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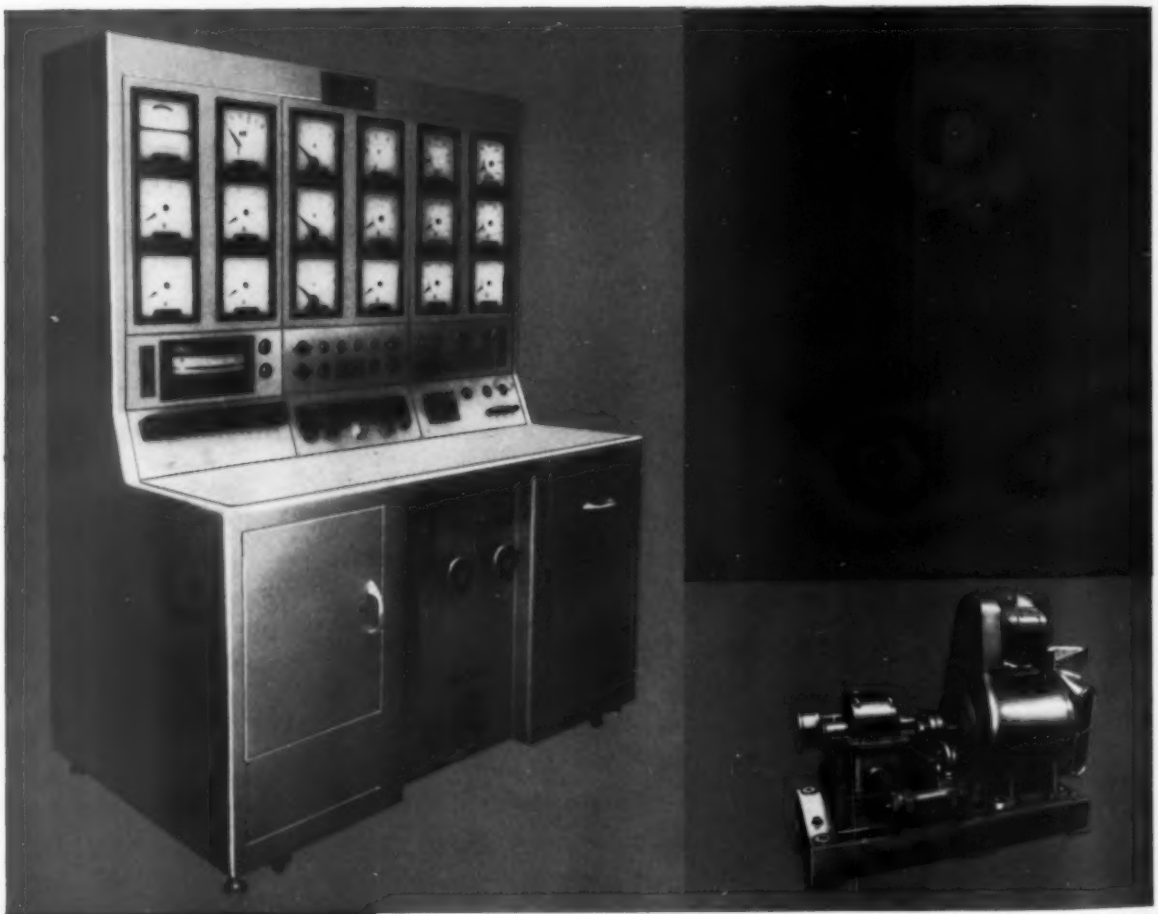

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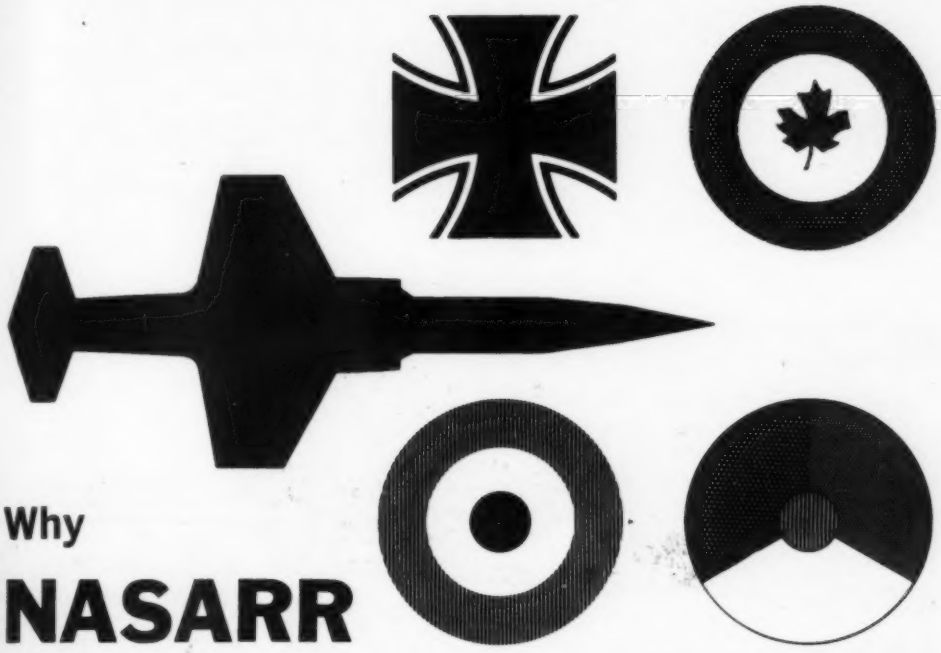

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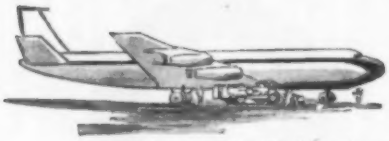

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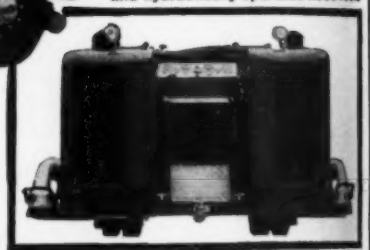

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HAWKER SIDDELEY AVIATION *32 Duke Street, London, S.W.1*

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FLIGHT

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Freedom Under Control

FOR Britain this could be the year of the small aeroplane—the year when private and business flying truly came into its own. First, there is the prospect of a complete new range of British business aircraft. "I am watching BEAGLE," writes Max Karant, vice-president of the US Aircraft Owners and Pilots Association, in a letter to *Flight*, "with great interest—and trepidation." Next, the clamant voices of the representatives of Britain's 6,000 private pilots, could—in volume and unison—raise the rafters of restriction. They may not yet all be shouting together, but at least they are shouting to be heard.

One such voice is that of "P.P.O.," a new contributor to *Flight's* Sport and Business columns; his advocacy is for a commonsense freedom for the sporting and touring side of private flying. "The more freedom you give it," he says, "the more it will thrive. Just now it is nearly dead because the Ministry . . . are trying to legislate for the millionth chance."

Some slight progress has been made. Single-engined aircraft are to be allowed to use Heathrow. The London Control Zone has been reshaped to the advantage of the private pilot. More sensible free lanes have been established through the Manchester zone. But against this, it was announced last week that the London zone, and all Britain's airways, would normally be closed to light aircraft. Though part of an inevitable process, perhaps, the applying of restriction in this way is unjust because airspace is taken away from the private pilot without anything being given in return.

There are better ways of furthering private flying than raising Cain for the unconditional lifting of restrictions. The problems of sharing aerodromes and airspace between commercial and private users are too complex to be solved without a generous helping of imagination from the bran-barrel of new ideas. The private pilot's *Air Pilot* is still awaited. But perhaps the most pressing need is for re-examination of the place of light aircraft in and under controlled airspace—not in a piecemeal fashion as now, but on a logical, shared basis. Partnership of the skies is a subject that will be examined in our Sport and Business pages next week, in relation to ideas now being adopted in the USA and France.

There is a warning here. If British sporting and business flying atrophies for lack of development, the home market for Beagles will succumb along with it.

No Distance on Bearing

A LACONIC ICAO news-release last week announced, *inter alia,* that the special European-Mediterranean regional meeting just concluded in Paris had decided on a distribution plan for the short-range navigation beacons, DMET and VOR, in the ICAO Eumed region. There had, it said, been some difficulty in assigning frequencies because of the large number (550) of facilities involved.

Now, DMET is supposed to give distance measuring to complement the bearings derived from VOR and, obviously, both beacons ought to be close together—what use is a bearing from one point and a distance from another? But DMET is part of Tacan, and that is a military aid for which an extensive network of beacons is already planned or working. There is no room in the frequency band for any more, and too few Tacans are close enough to their related VOR. So DMET, the cream on the VOR bun, has gone sour. So much so (see page 209 of this issue) that IATA, who were ardent DMET fans a year ago, now virtually disown it; some airlines refuse to use it; and the airline pilots' associations dislike it. But ICAO is committed and, it seems, we must all pay handsomely and lump it. If you can push a white elephant into your neighbour's garden, he must feed it, whether he can ride it or not.

CERTIFICATION of the Comet 4C by the American FAA, as specified by Latin-American carriers, was officially signified on February 13 when Mr R. B. Myersberg, FAA European representative, handed the certificate to D.H. Aircraft managing director Mr H. G. Sturgeon, seen holding it. Looking on, l to r: Mr L. Morda, FAA; Mr C. T. Wilkins, D.H. Aircraft chief designer; Mr R. E. Hardingham, chief executive, ARB; Mr John Cunningham, D.H. Aircraft director and chief test pilot; and Mr A. G. Peters, D.H. Aircraft general manager

FROM ALL QUARTERS

STOL Transport for the RAF?

FOR many months it has been evident that the RAF will shortly find a need for an STOL (or possibly even VTOL) transport, both to support V/STOL combat aircraft and to handle airlifts into inaccessible locations—or at a time when conventional airfields might be destroyed. According to the London *Sunday Telegraph* the Air Ministry has already issued a draft Operational Requirement. It is stated that Bristol Aircraft are submitting an entirely new design, that Armstrong Whitworth have offered an enlarged STOL Argosy and Short & Harland an STOL version of the Belfast. Elsewhere it has been suggested that Hawker Siddeley have evolved several blown-flap or tilt-wing aircraft, and the Advanced Projects Group at Kingston are known to have been devoting much attention to this field.

Meanwhile, Lockheed Aircraft have already found a receptive ear in the British industry for a plan for licence-production of an Anglicized version of the C-130 Hercules. The suggestion is that the blown-flap C-130C—otherwise known as the BLC-130, owing to its boundary-layer control system—should be converted to British requirements, powered by four Rolls-Royce Tynes and manufactured by British Aircraft Corporation, probably at Filton. This appears to give Bristol Aircraft two irons in the fire, although it is doubtful if either could be produced to a shorter time-scale than those of Hawker Siddeley. Lead-time quoted for the BLC-130 is "36 to 40 months."

IFR: The Blanket Descends

MINISTRY OF AVIATION Notam 51/1961 is already famous (or notorious); it specifies that as from March 1, the whole of the London control zone, and the whole of Great Britain's airways system, will be permanently under instrument-flight rules. "Special VFR" clearances will have to be obtained to enter the zone or cross airways by any pilot who has not filed an IFR flight plan and does not hold an instrument rating; this will require a radio call to London approach, or to the appropriate Air Traffic Control Centre.

Normally special VFR clearances will be given only to aircraft travelling to or from an airfield within the zone, or who wish to transit it at low level. At Northolt, Denham, White Waltham and Fairoaks there are now permanent restrictions on inbound and outbound traffic. Entry and exit must be along the various free lanes, and maximum height restrictions and limits on visibility are in force at all times.

For aircraft on IFR flight plans, VMC climb and descent clearances may be given to avoid delays, but "VMC on top" cruising-level clearances are now outdated. Aircraft flying VMC may cross airways, but must call the ATCC ten minutes' flying time from the intended crossing-point.

Westland's "Vital Decision"

REFERENCE is made in the annual report of Westland Aircraft Ltd to preliminary design work on the Bristol 194, a tandem-rotor 40/48-seater helicopter powered by four D.H. Gnome gas turbines. Mentioning this project and the existing Fairey Rotodyne and the suspended Westminster, the report states: "the decision as to the project on which to concentrate resources is a vital one for the future of the company. Very detailed discussions on all aspects of this have been taking place with the Ministry of Aviation and civil operators during the last few months, and it is hoped that they will be completed in the very near future." Mentioning the smaller helicopters, Westland say that both a development contract and a considerable production order have been received for the Scout ("hitherto called the Wasp or P.531").

As a result of last year's mergers Westland now operate four helicopter divisions and two principal British subsidiaries in six different locations. The most recently acquired concerns were effectively purchased as from January 1 this year, and their financial results for the nine months starting on that date have been embodied in the consolidated profit and loss account. The group's consolidated profit after taxation amounts to £1,330,861.

Boeing 707-320B

AS we go to press, Boeing confirm the existence of the 707-320B, which they describe as "the world's longest-ranged jetliner." Powered by four Pratt & Whitney JT3D-3 turbofans, each rated at 18,000lb with water injection, the 320B has full-span flaps on the leading edge and "improved" trailing-edge flaps; a note on Boeing's flap-blowing research was included in our analysis of the 727 on December 16. Maximum taxi weight is 317,000lb, and a payload of 40,000lb can be carried over a still-air range of 5,400 miles—a 15 per cent improvement over the 320. Concurrently with these details, Boeing announce the sale of five 320Bs to PanAm.

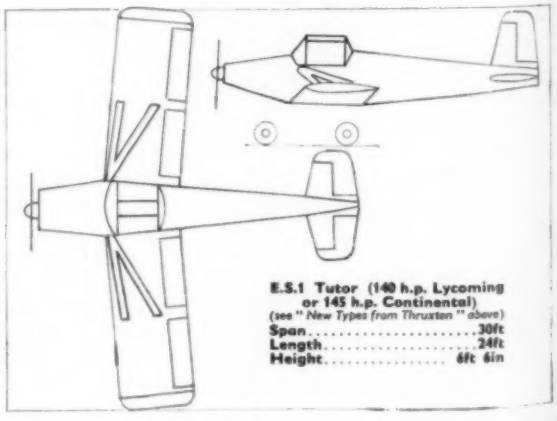
Il-18 Incident

ALLEGATIONS that an Il-18 carrying the Soviet President, Mr Leonid Brezhnev, to Morocco on February 9 was fired on by French fighters when 80 miles north of Algiers at about 27,000ft were made by the Russian authorities last week. In a published protest, they said that the French authorities had been informed in advance of the Il-18's flight. A French spokesman in Algiers confirmed that fighters had fired "warning shots" in the direction of a Russian airliner which had entered the French "zone of responsibility" off the Algerian coast. At first it was stated that the Russians had not filed an international flight plan; then the French said that the aircraft had committed "several irregularities and breaches of the rules." On the evening of February 10, however, the French Chargé d'Affaires in Moscow called at the Soviet Foreign Ministry to express the French Government's sincere regret for a "regrettable incident." The fighters were Vautours.

New Types From Thruxton

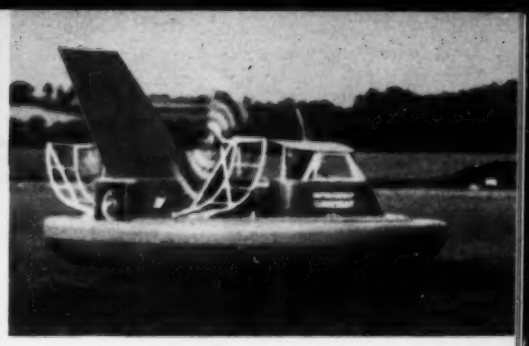
A NEW two-seat training aircraft and a four-seat tourer, basically identical in design and construction except for powerplant, cabin length and span, have been designed by the Wiltshire School of Flying at Thruxton Aerodrome. They are the E.S.1 Tutor, illustrated below, and the E.S.2 Paragon (the original version of which was described in *Flight* for February 27, 1959). The initials are those of Mr Eric Smith, who has been responsible for most of the design work on the two projects.

Powered by a 140 h.p. Lycoming or a 145 h.p. Continental engine, the factory price of the Tutor will be about £2,200 and the probable retail price about £2,500. The four-seat Paragon, powered by a 180 h.p. Lycoming or a 175 h.p. Continental, will



E.S.1 Tutor (140 h.p. Lycoming or 145 h.p. Continental)
(see "New Types from Thruxton" above)
Span 30ft
Length 24ft
Height 6ft 6in

RETIRING after 38 years with Hawker Aircraft is Mr A. R. Turner, assistant experimental supervisor at Dunsfold Airfield. Here, at a farewell party, he is with chief test pilot Bill Bedford (left) and Gp Capt "George" Bulman (right), chief test pilot from 1933 to 1945



CUSHION RIDING: Seen, right, on a recent test with its stabilizing fin in place, Britten-Norman's Cushioncraft is shortly to resume trials. Reinforced fan-track-supporting rollers have been fitted, and spoilers on either side of the duct control lateral motion when operated by pedals. The scene is Bembridge Airport, Isle of Wight

have a factory price of approximately £2,500 and a probable retail price of some £2,900.

The simple method of construction employed makes use of fuselage girders, either prefabricated in welded steel tube or stamped out of sheet metal, connected by substantially flat spacing and bracing structures. The company is currently negotiating with companies in this country, Canada and Switzerland, with the object of producing the two aircraft on a large scale.

Commuting by VTOL

"ALL the signs are that we are on the threshold of a new era of materials of enormously greater strength than we use today. But it will take time and money, for much research and development remains to be tackled, and a whole new technique learnt. With the lighter aircraft and engines which will then become available and with the development of air traffic control VTOL also becomes a certainty, firstly from open country, but as the noise problem is conquered, penetrating farther into cities. Once this is achieved it is hard to set any limit to the use to which these vehicles can be put."

This glimpse into the VTOL future was given by Air Chief Marshal Sir Ralph Cochrane to the Institute of Transport in London last Monday. Sir Ralph, formerly Vice-Chief of the Air Staff and now in charge of Rolls-Royce long-term research, was delivering the Brancker Memorial lecture; his subject was *Aviation —the Next Stage?*

Sperry/BEA Helicopter Flight Director

BEA and Sperry combined last week to demonstrate the latest version of a flight director which will allow helicopters to be accurately and easily flown on instruments. Roll and pitch commands for stabilization, and for speed-, heading- and height-holding and turns at constant rate at any speed, are presented on a standard Zero Reader cross-pointer. Collective-pitch commands for barometric height and glide-slope holding at low speeds are shown on a Smiths Para-Visual Director unit. The cross-pointer gives control-position demands and not attitude instructions, and the experimental Whirlwind proved easy to fly in turbulence on this instrument alone. A *Flight* representative with limited helicopter experience was able to fly the Whirlwind accurately at set speeds and make turns without difficulty.

The present test equipment is the result of several years of joint BEA, Sperry and MoA effort and will lead in due course to instruments incorporating roller-blind attitude presentation as well as control demands. BEA have been systematically preparing for airline helicopter operations. Their work, and that of other companies, will be the subject of a special-feature review of helicopter all-weather operation in *Flight* next week.

VHF Radio For Transport Command

AN initial order worth £500,000 has been placed with the Airborne Radio and Radar Division of Elliott Brothers (London) Ltd for 21-series VHF communication and navigation radio for Transport Command aircraft. Elliott have for some time been manufacturing this lightweight radio under licence from the Bendix Corporation and the units so far produced have been fitted in a wide variety of aircraft and used in Britain, South America, South Africa, Australia and the Far East. American-made 21-series radio has been ordered by many civil operators and several air forces.

The Elliott equipment now ordered will be fitted in Transport Command Argosies, Belfasts and Comet 4Cs, the first two of which will have automatic landing capability.

Salisbury Rendezvous

ANNUALLY, representatives of the aircraft firms which have outposts at Boscombe Down converge on Salisbury for a social rendezvous with Service and civilian officers of the Aeroplane and Armament Experimental Establishment. On Wednesday of last week the eighth such function was held, with an attendance of about a hundred representatives and guests—a total slightly below that expected, owing to the southward-moving influenza epidemic.

Air Cdre J. F. Roulston, the AOC, made a gallant first appearance at such a function after having barely recovered from 'flu: in a brief speech he referred to the recent aircraft industry mergers, pointing out that they still made possible "excellent parties like this," and saying how appreciative he was of the function and how well it had been arranged. The air commodore (who took over as AOC last year from Air Cdre A. E. Clouston) was introduced by a member of the organizing committee, Mr. P. E. Pearce of Bristol Siddeley, who welcomed the representatives' guests. Despite the mergers, there were more firms than ever represented at this year's Salisbury function; 32 were listed, compared with 29 in 1960.

VLF as a Navigation Aid

A RECENT series of flights with the RAE Comet 2E to Malta and Africa have shown that the VLF ranging equipment first exhibited at the SBAC Show last year, and described in *Flight* for September 16, is giving positional accuracies of about one mile. Presumably both GBR Rugby on 16kc/s and Balboa in the Panama Canal zone are now being used, together with the Marconi frequency standard carried in the aircraft. Range measurement is done by keeping a continuous count of phase changes in the signal from the transmitter with the stable oscillator. Six special VLF transmitters could give world-wide coverage, but several problems remain to be solved, not least that of providing the airborne frequency standard in a form manageable for routine operations.

IN BRIEF

The first Republic F-105 Thunderchiefs to be based outside the USA are soon to join the 36th Tactical Wing at Bitburg, Germany.

The Short Sunderland which is being brought to this country for preservation is to be flown over from Brest to Pembroke Dock by a French Navy crew on March 24.

A consortium consisting of Hiller, Chance Vought and Ryan is to develop a VTOL assault transport for the USAF, Army and Navy. Detailed design will begin "in four or five months," and the aircraft should be ready to fly by the summer of 1963.

United Aircraft Corporation have announced that an option for licence-manufacture of the Sikorsky S-61D has been granted to Weser Flugzeugbau GmbH, Bremen, Germany. United state that "the twin-turbine, boat-hull S-61D is being offered to the Federal German Republic to fill its large helicopter transport requirement."

On the night of February 7 a Black Knight reached an apogee of 350 miles and landed 60 miles from its pad at Woomera. Announcing this, Mr A. S. Hulme, Australian Minister for Supply, said that the firing had been authorized to measure radio noise, ionospheric measurements and observations of re-entry phenomena.

A Defence Ministry spokesman said in Bonn last week that the RAF is to provide 80 instructors for the West German Air Force, for a two-and-a-half year tour of duty. Of the 100 RAF instructors detached to train West German pilots under the 1958 agreement, 65 were staying for a second 2½ year tour, beginning this year. The RAF were posting 35 of the original 100 to other duties; 15 others would take their places.

A "Swedish evening" is being held by the London Society of Air-Britain in the lecture-theatre of the new Holborn Central Library, 32-38 Theobalds Road, London WC1, on March 1. A talk is to be given by the Swedish Air Attaché, Col G. Tegner, and widescreen films of the Draken and Lansen will be shown. At the meeting, a draw for the Society's 100th enrolment will be made.

The increased MATS air-lift ability authorized by President Kennedy (February 10 issue, page 169) begins with 23 Lockheed C-130s and 30 Boeing C-135s. The latter will be similar to the 450 KC-135 tankers in service with SAC, apart from deletion of the fuel-transfer boom, and they will carry a 64,000lb payload more than 4,000 miles. First delivery is scheduled for June this year.

Barry Radley, well known as a Hunting Aircraft test pilot (he joined Hunting Percival in 1953 and took part in Jet Provost development flying), is leaving the company to join IATA. He took up his new appointment last Wednesday (February 15), becoming assistant to the technical director, Mr S. Krzyczkowski. In his Montreal post, Mr Radley will be responsible for the flight technical group. An ETPS graduate (No 8 Course, 1949), he is also an ARAeS.

The New Shape of the Industry

as seen by

SIR GEORGE EDWARDS,
CBE, BSc, Hon FRAeS, Hon FIAS,
Executive Director (Aircraft) British Aircraft Corporation; Managing Director, Vickers-Armstrongs (Aircraft) Ltd.

in an interview with FRANK BESWICK

WHAT I always found fascinating about George Edwards was his unqualified zest for the job in hand. Often enough in industry one comes across men with an impressive factual grasp of the business which they direct (many such are lawyers and accountants by training) but G.R.E., an engineer, has more than that; he has a feeling for, an affinity with, the affairs which he directs.

There were times, one thought, when this whole-hearted attitude to the job led him to over-work. Occasionally, indeed, he would confess, "Yes, probably I have had the wick turned up a bit too high." Nowadays his energies are spread over an even wider field, and my first question was on this point of larger-scale organizations.

Many of us have laid down theories about the virtues of bigger units in the British aircraft industry; how is it working out in practice?

"Surprisingly well—and there is no easy optimism about that statement, either. Of course, when you have four firms each with chaps who have been stalking each other for years and suddenly they are asked to get together, it is no good pretending that problems don't exist. What helped us was the TSR.2 running-in period; we had two teams of designers, from Vickers and English Electric, working together for a year before the merger."

What did this working together mean, in terms of people and desks, at Weybridge and Warton?

"We had about equal numbers from both companies, making up a complete team of about 50. They had before them the Vickers submission which placed emphasis on short take-off, and there was the English Electric submission with emphasis on gust response. Between them they hammered out an aircraft. Getting the two groups together, each impressing the other with the strength of its ideas, did both sides a lot of good. Opposing solutions were entailed, but we now have a composite aircraft with the best of both worlds."

But who is the boss in this kind of joint enterprise? Someone must be, presumably?

"Certainly there must be a boss. Before the decision was taken we were firm that either Vickers or English Electric were awarded the contract. In this particular case Vickers got the contract and they appointed the boss, but it has since become a joint BAC effort with the work shared between Weybridge and Warton. There is a lot of to-ing and fro-ing, but an aerial bus makes constant contact possible. I am quite sure that the two teams have hammered out an extraordinarily good aeroplane."

If this kind of joint success is possible with two separate companies, is it not an argument against the merging that has taken place?

"No, it is not. After twelve months' experience I would say we have done the right thing. I have always thought we had to get down to fewer units, one way or the other, and we can now see the advantages. We have put out a lot of the work on the VC10 and later marks of the Lightning to Filton, and Huntings also have work that originated here. That kind of flexibility is valuable. All the new jobs are planned to be designed and built in more than one plant.

"Mind you, we don't want to over-centralize. There was a great wave of centralization to begin with, but then, further down the road, one realizes the necessity to preserve identities. I am against the idea of one central cathedral with all the great thinkers seated in splendid isolation, and merely making use of the chaps on the fringe. The latter want their own projects as well."

But is there use for all these projects? Aren't we still trying to do too much?

"The fact is that the manned aircraft has not taken the back seat that was forecast; it is a weapons system which has great flexibility, and the military commanders are beginning to realize that they need it. I think we shall see many more new projects conceived around it."

A little earlier you spoke about flexibility. With an overall shortage of design and technical staff can you really get flexibility?

"One of my jobs now is to get our programme finally set out so that I do get more flexibility. You are quite right—we have not enough staff to do all that we should like. But we have to take projects up to the starting tape. We don't necessarily want to run them all—or, at any rate, we don't want to start them all in a race. What we *must* do is to keep them going until we are pretty well convinced that a market is there to merit the risk involved. Unfortunately, the real risk never seems to be the one you originally visualized. Take the Vanguard. As the project stands now it cost more than we thought; research and development always cost more than you calculate. This is partly because of an unrecoverable inflation that escalator clauses do not allow for. The delays with the Tyne are examples of unexpected extra cost. These are the things that make you pause jolly hard before you go into another big civil private venture. I doubt very much whether any of us will be able to afford another big private-venture civil aircraft unless we get adequate Government backing."

This is rather a different story from what one heard not so very long ago, when you were all prepared to rush into p.v. civil projects.

"One of the attractions was the stability in employment which these contracts provide—unlike Government work, which can disappear by changes in policy, for defence or other reasons. But the risks now are so great that I doubt if any British company can afford to accept them."

What kind of risks have you in mind?

"Well, supposing you have a £100m contract and there is a 5 per cent addition to costs. It may be something quite outside one's own control that pushes up our costs, but selling prices are fixed. A 5 per cent error in calculations on a civil contract is nothing compared with the disclosures by the Select Committees on some of these military projects. But 5 per cent on £100m means a matter of £5m, which is not easy for any company to absorb. As I say, our prices have been fixed; and when we are competing against other machines which are being sold at less than cost, then our fixed prices cannot have a built-in margin for error. If your readers want to know what I mean about our competitors selling machines below cost then I suggest they read an article in *Forbes Business and Finance*, which gave the whole story about America's experience."

If it is accepted that modern projects are so big, and involve intolerable risks, isn't that an argument for an even bigger organization? Does it not mean that we have to cut out all overlapping?

"There may be something in that. Perhaps there is a certain amount of overlapping, and we cannot afford to tread on each other's toes. I agree in principle with Sir Roy Dobson that we should cut out unnecessary competition with one another in the world's markets."

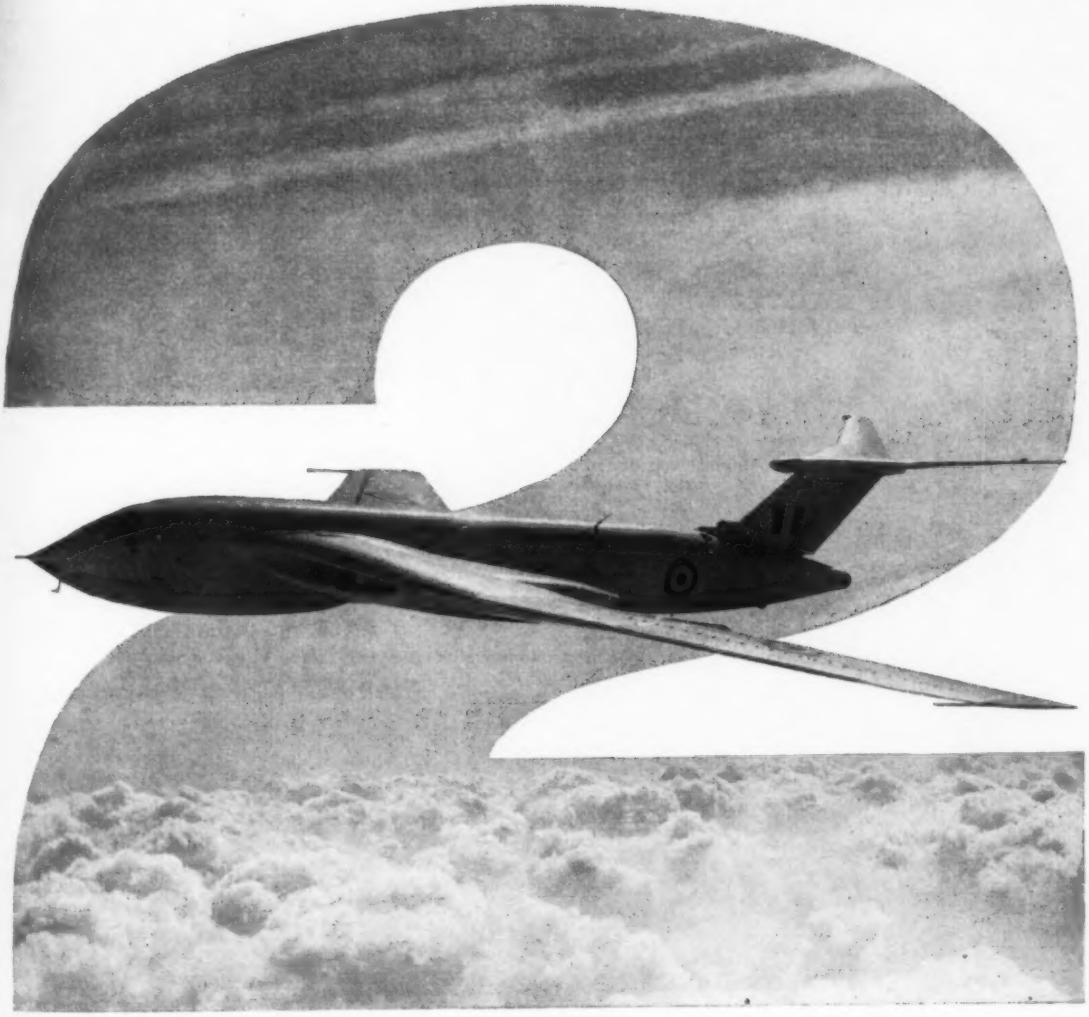
As far as Government assistance is concerned, have you any formula to offer?

"We are in the process of shaping ideas. If you put the question to me in about a month's time I may be able to give you an answer."

Do you think it is possible to evolve a formula which will afford protection against unwarrantable risks without also offering a

Concluded on page 226

mightier VICTORS will keep your peace

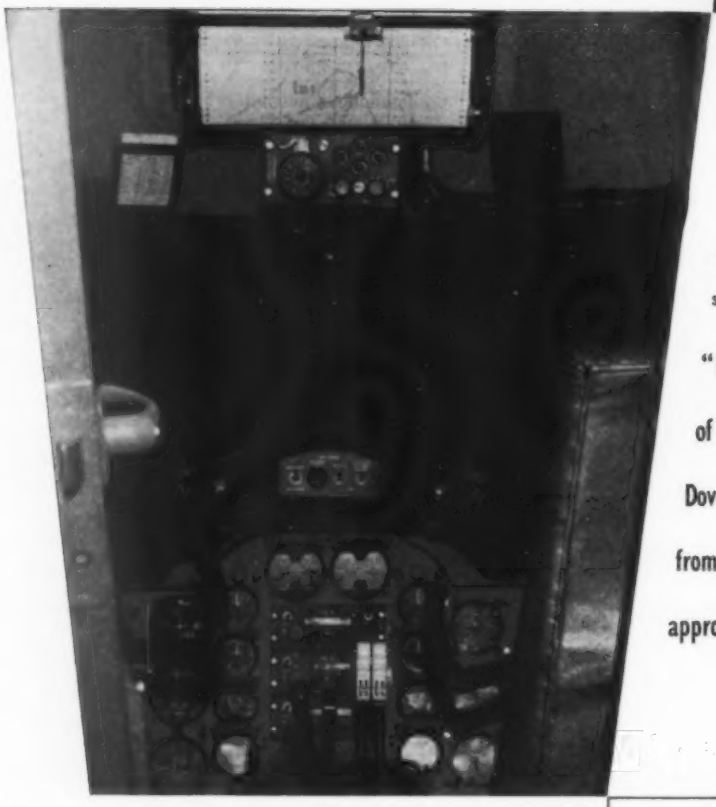


Victor 2s are even more potent versions of the sonic Victor 1s in V-bomber service with the Royal Air Force — and still the largest aircraft to have breached the sound barrier.

HANDLEY PAGE RADLETT · LONDON · READING

MR. J. C. BAMFORD, Chairman and Managing Director of J. C. Bamford (Excavators) Ltd says:

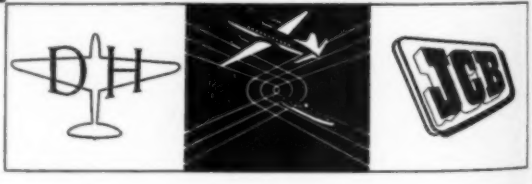
"We fitted Decca because we operate into many small, ill-equipped airfields all over Europe and we must be able to fly in any weather day or night, with the same regularity as from any major airfield".



THE DE HAVILLAND AIRCRAFT CO. LTD., suppliers of the DOVE 8 aircraft, state:

"Decca is a proven system for the operator of executive aircraft such as the De Havilland Dove 8 who must frequently navigate away from airways and use airfields where approach facilities are often non-existent".

Cockpit of the De Havilland Dove 8 owned by J. C. Bamford (Excavators) Ltd., showing the Decca Flight Log and Decometers. The installation consists of a Decca Mark 8 Receiver (½ ATR) and Computor (½ ATR), Flight Log and Receiver control boxes and display head, the total weight of all units being less than 45 lbs.



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for executive aircraft

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Missiles and Spaceflight

TOWARDS VENUS

The most significant new space development since Lunik 2 hit the Moon on September 13, 1959, was the orbital launch of a space probe towards the planet Venus by the Soviet Union on February 12. This was the first launch of a space probe from an artificial satellite in orbit around the Earth, and apparently explained much of the mystery which had surrounded the firing of the heavyweight (6½-ton) satellite into a low Earth orbit eight days before.

The initial Tass announcement gave the news as follows:—

"In conformity with the Soviet space research programme, a heavy artificial satellite of the Earth was orbited in the Soviet Union on February 12, 1961, by an improved multi-stage rocket. On the same day a guided space rocket, launched from the sputnik, set an automatic interplanetary station on a flight to the planet Venus.

"The automatic interplanetary station will reach the area of the planet Venus in the second half of May 1961. The main object of the probe is to check the methods of placing a space body into an interplanetary trajectory, to check radio communications over super-long distances and the guiding of a space station, to check more exactly the size of the solar system and to carry out a programme of physical observations in outer space.

"Equipment on board the interplanetary station is functioning normally. The weight of the automatic interplanetary station is 643.5kg (1,418lb). Radio transmissions from the automatic interplanetary station are made on the frequency of 922.8kc/s (later given as 922.8Mc/s by Moscow Radio) on command from the Earth.

"The automatic interplanetary station is carrying a pennant with the coat of arms of the USSR. The flight of the automatic interplanetary station is being tracked by a special centre. According to information to hand, the automatic interplanetary station is moving along an orbit close to that calculated.

"At 1200 Moscow time today the station was 126,300km (78,500 miles) from the Earth over the point on the Earth's surface at 86° 40′ East and 6° 04′ North. The successful launching of a space rocket to the planet Venus blazes the first path to the planets of the solar system."

Speaking earlier in Moscow, the principal scientific secretary of the Soviet Academy of Sciences, Evgeny Fyodorov, had pointed out that it would be a practical impossibility to set a trajectory with the necessary accuracy from the start of a flight to Mars or Venus. In-flight corrections would be needed, he said, and this made it necessary to have reliable communications over distances of over 60 million miles.

Commenting on the Tass announcement, Dr I. M. Leavitt, director of the Fells Planetarium, Philadelphia, said: "The interesting thing about this new launching is that they are aiming for Venus when it will be more than 30 million miles away, and are planning to cover the distance in about 100 days. The normal time is over 146 days on the most economical orbit. This would indicate they must have some fuel and guidance system."

Dr Hugh Dryden, Deputy Administrator of the US National Aeronautics and Space Administration, said that, if all went well, the United States would expect to attempt a planetary launching from an Earth satellite in another eighteen months to two years.

It appears clear that the launching of the 6½-ton satellite on February 4, about which very little was said by any official Soviet source, was either a preliminary test in connection with the orbital launch system or an unsuccessful attempt to launch a probe to Venus. Speaking in Moscow two days before the Venus launch, Prof Leonid Sedov referred to the February 4 satellite as follows:—

"On board the satellite there was no special equipment for the scientific study of outer space. Nor were there any experimental animals, for it was the first time such a ship had been launched. The launching was purely experimental.

"I would also like to note that the rumours which have been spread abroad to the effect that there is a human being on this satellite do not accord with reality. The main task of this flight was the following: First, the task of placing so big a satellite into orbit, and then the study of the parameters which characterize the operation of its design. With this in mind a radio telemetric system was installed on board the satellite to check on the parameters of the elements of the design.

"Secondly, a no less important and at the same time very difficult task is the extremely accurate placing into the planned orbit of a heavy satellite. That was achieved successfully. With the help of equipment for trajectory measurements installed on board the satellite the necessary measurements and observations were made. With the help of a terrestrial measuring and computing complex it was established that the satellite moves along an orbit the parameters of which come very near to those of the intended orbit.

"No special system for the satellite's return to Earth was provided for in this experimental launching. Owing to its low orbit the existence of the satellite will be brief, and in the very near future the satellite will enter dense layers of the atmosphere and cease to exist. The experiment carried out with so heavy a satellite which was accurately placed in orbit opens up many possibilities for the installation of improved scientific equipment of sufficiently large dimensions intended for a long period of operation, as well as the solution of tasks connected with the study of outer space."

At the Nuffield Radio Astronomy Station at Jodrell Bank, Cheshire, there were two main obstacles to the tracking by the 250ft steerable radio telescope of the Venus probe. First, the 922.8Mc/s frequency was not one of the standard frequencies received at the station, and a special receiver and aerial had to be set up. Secondly, it was essential to know where and when to look for the probe, since the beam width of the telescope would be only one-third of a degree. Work was begun on preparing the equipment, and on Monday last, February 13, a telegram was sent by Sir Bernard Lovell, professor of radio astronomy at Manchester University and director of the station, to a colleague in Moscow, asking for co-ordinates of the probe to be computed for Jodrell Bank, and for details to be sent of the times during which transmissions from the probe were being commanded from the ground.

DISTURBED BLUE WATERS

Last week the West German Army revealed that they had purchased a battery (perhaps four launchers) of Sergeant tactical ballistic missiles. This was seized upon by the London *Sunday Telegraph* as implying that the American weapon had been adopted as a standard NATO weapon, concluding: "This means that the British Blue Water missile in the same class will find no sale in Europe." As we go to press no evidence is available to justify this extreme view, although it would be idle to deny that any non-American weapon is—under Kennedy—likely to have an even stiffer fight than before in seeking NATO adoption.

Blue Water, the corps-support weapon developed by English Electric Aviation, is a complete weapon system which should be able to do all that Sergeant can do for a very much reduced cost. It is a much smaller missile, and the complete weapon system is a fraction of the weight of that of Sergeant, and has better cross-country performance. Late in 1959 the NATO Military Committee included Blue Water in a list of weapons chosen for joint development and manufacture by several of the 15 member-nations, and for more than a year the British and German Governments have been discussing plans for its joint production. The War Office have demonstrated Blue Water in the USA, and the British weapon's technical superiority appears to be generally acknowledged. Germany's purchase of a limited quantity of Sergeants is not unexpected, since this American weapon is some 18 months ahead of Blue Water in timing; but it should not be construed as meaning that a European weapon has once again been bulldozed out of the way.

On February 6 the second stage of a Polaris A2 ignited on the pad at Cape Canaveral. It flew furiously until impacting some 500yd away, while the first stage burnt on the pad.

The Federal German Defence Ministry announced on February 2 the purchase of "several hundred" Laura anti-submarine rockets from the Swedish Bofors Co and its French subsidiary. Laura is a simple unguided rocket, some 78in in length, suitable for mounting on small craft.

NASA announced at the Marshall Space Flight Center that on February 10 a thrust of 1,550,000lb was achieved briefly during a test on a prototype chamber "connected with the F-1 program." This is the highest thrust achieved in the Western World from a single rocket chamber.

On February 5 NASA launched from Wallops Island the first of a series of Aerobee rockets containing a vacuum flask partially filled with liquid hydrogen, carried on a stable platform. The 303lb payload was taken to an altitude of 94 miles, and during 5min of weightless flight its behaviour was telemetered to Earth. A photographic record was also obtained, but although the capsule was seen floating in the Atlantic it was not recovered.

A North American X-15 research aircraft fitted with the new rounded "hot nose" and flown by Maj Robert White, USAF, set up an unofficial world speed record of 2,275 m.p.h. on February 7. The aircraft was released from a B-52 after take-off from Edwards AFB, California.

An indefinite suspension of the programming of wide-angle photographs from Tiros 2, the experimental weather-observation satellite launched on November 23, 1960, was announced by NASA on January 19. This followed "a malfunction causing unprogrammed effects in the timing clock operation and the wide-angle camera system". The programming of remote narrow-angle photographs, also, was suspended temporarily pending a study of erratic behaviour.

In the Civil Appropriation Accounts published on February 7 it is noted that the original 1955 estimate for the Blue Streak programme was £50m. This figure was revised in 1957 to "between £160m and £200m," and it was later estimated that including deployment costs, the total cost of the project might reach "something of the order of £500m to £600m." Total cost up to March 31 last (immediately before cancellation) was about £67m, of which £23m had gone to the four main contractors, £21m had been spent at Spadeadam and about £9.5m was accounted for by installations at Woomera.

Missiles and Spaceflight . . .

STRASBOURG PROPOSALS DETAILED

THE proposals which the British and French delegates placed before the twelve-nation conference at Strasbourg at the turn of last month, reported in last week's issue, were based on Royal Aircraft Establishment studies into the adaptation of British rockets for satellite launching, followed by joint Anglo-French investigations. The first principle, from which the detailed reasoning was developed, was simply that Blue Streak, with over one hundred tons of thrust at launch, was capable of providing the first stage of a satellite launching vehicle of great versatility and power.

To minimize the cost of any possible future programme, it was decided to make the greatest possible use of existing equipment and facilities, including the rocket ground-testing and development facilities at Hatfield and Spadeadam and also the launching and other range facilities of the Weapons Research Establishment at Woomera. Apart from stripping off the military items, modifications to Blue Streak were to be kept to a minimum. The French proposal for a second stage, also, was based closely on the national programme already undertaken on basic studies and development of ballistic missiles.

At the beginning of the design studies, performance aims were established in consultation with the British National Committee on Space Research, and were expressed in terms of three categories of satellite:—

(1) A space-stabilized astronomical satellite weighing 1,000-2,000lb to be launched into a low near-circular orbit.

(2) A smaller satellite weighing several hundred pounds, moving in an eccentric orbit (as far out as two or three Earth radii) for the investigation of the Earth's gravitational, magnetic and radiation fields and the constitution of the Earth's outer atmosphere.

(3) A 100lb satellite to be launched into a highly eccentric orbit (reaching out to about 100,000 miles) to carry instruments for the study of the Sun's atmosphere.

These aims were subsequently extended to include the possible launching requirements of communications satellites, and this led to the additional consideration of circular orbits at an altitude of several thousand miles.

These various requirements implied differences in the best launching vehicle to meet them. A three-stage vehicle was adopted, with only the third stage being varied to meet the differing orbital requirements.

The first stage, Blue Streak, stripped of its military guidance equipment and warhead, would require modification only in the separation bay, which would be tailored to carry the second stage. The existing liquid-oxygen/kerosine engine, of which there are two, is currently rated at 137,000lb thrust at sea level but is capable of uprating to 150,000lb thrust, which might be desirable in certain satellite applications. The first-stage rocket structure would be adequate for the more severe conditions arising from the extra stages and from the increase in thrust.

Originally the British proposal for the second stage was for a developed version of the Black Knight ballistic research vehicle. The idea was abandoned and a proposed French second stage was adopted. This stage would use the high energy hypergolic propellant combination of nitrogen tetroxide and unsymmetrical di-methyl hydrazine, with a sea-level specific impulse of at least 255sec. It would have a single-chamber motor of 25 tons thrust mounted on gimbals for control in pitch and yaw.

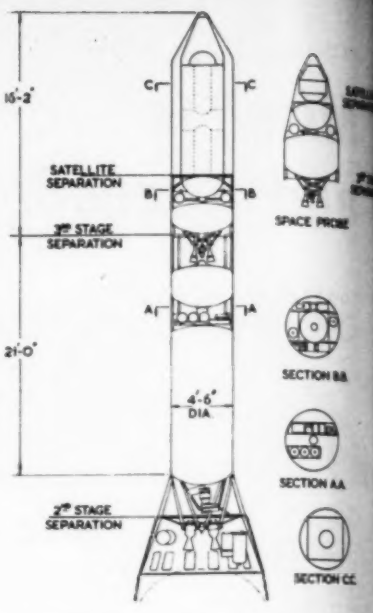


Fig 1. Original British proposal for second and third stages of satellite launch vehicle, using Blue Streak as first stage. This proposal was changed to include a French second stage and a final stage built by another country or group of countries

The combustion chamber and nozzle would employ film cooling by the fuel, a technique already developed for the French Véronique rocket. The tanks would be made from a vanadium alloy steel, Vasajet 90. Propellants would be pressure-fed into the combustion chamber using a solid-propellant gas generator. The second stage would also contain control and separation equipment including auxiliary roll-control jets fed from the gas generator, and rate gyros to provide information for the autopilot.

Studies indicated that it would be possible to inject a satellite into the lower-altitude orbits using only the first two of the proposed stages. But this would require a long coasting period after some 90 per cent of the second-stage propellants had been burnt, followed by a relight of the second-stage engine to inject both

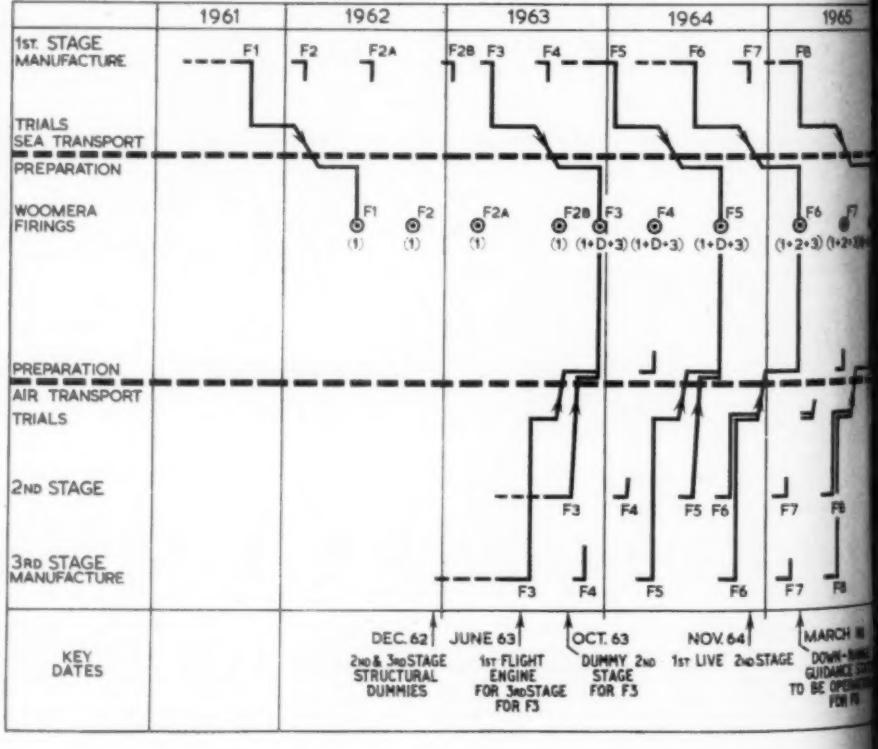
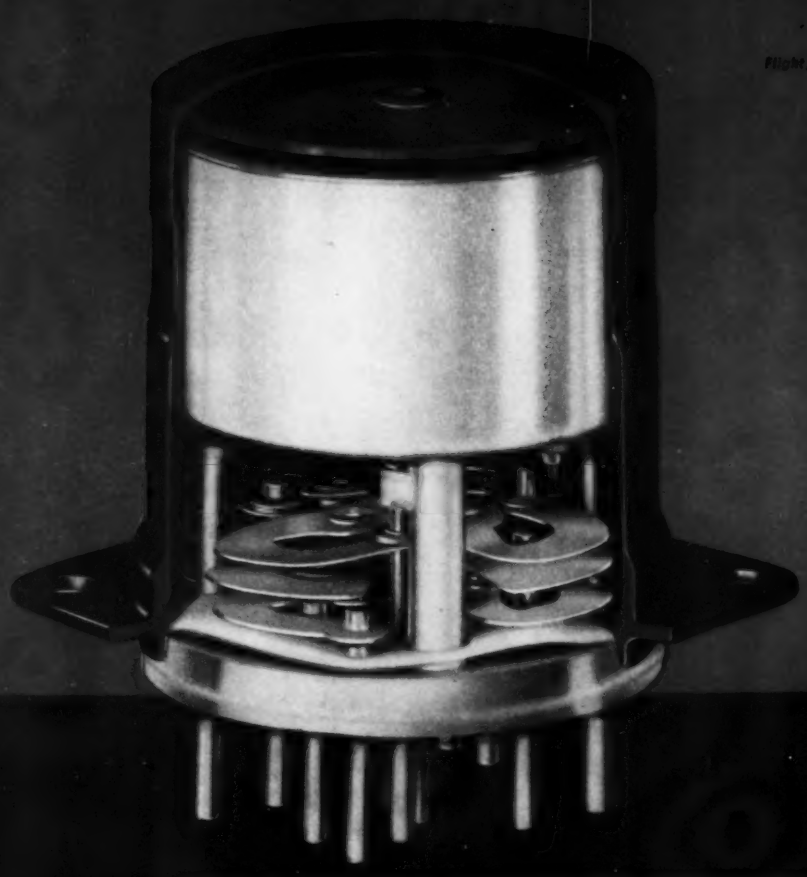


Fig 2. Overall development programme for the five-year scheme proposed by Britain and France at the Strasbourg conference. A total of ten firings (F1 to F8) are included, of which the last three would be of the complete three-stage vehicle and would be capable of placing a satellite in orbit. Launches F2A and F2B would if necessary use back-up vehicles for the first-stage firings; launches F3, F4 and F5 would carry a dummy second stage and live third stage



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BEA VANGUARD

BUILT BY VICKERS POWERED BY ROLLS-ROYCE

Newest in air travel

March 1961 is an important month for people who fly. For that is when BEA introduces the brand-new Vanguard jet-prop airliner on their Paris service.

Built by Vickers, the Vanguard has been specifically designed to meet the tremendous increase in European air travel. It is one of the largest airliners in the world, seating over 100 passengers in four spacious cabins.

Four Rolls-Royce Tyne jet-prop engines power the Vanguard. Extra-large freight holds and quick turn-round facilities ensure that it pays its way, all the way.

By introducing the Vanguard, BEA will be able to offer you more services with more seats available on them.

fly BEA

Missiles and Spaceflight . . .

satellite and the empty second stage into orbit. This method would introduce problems of relighting the engines under zero acceleration, as well as the need to ensure correct orientation of the second stage at engine relight.

Although such problems had been solved in other satellite launching vehicles, the addition of a small third-stage rocket was preferred. The engine of this stage, working at a relatively low thrust between 1,000 and 2,000lb, would be started during separation from the second stage and would continue to burn through what would otherwise be the coasting period, cutting off when orbital altitude and velocity had been achieved. The low weight of the third-stage engine structure, compared with that of the relit second-stage, could effect a considerable improvement in payload weight placed in orbit.

As finally agreed at Strasbourg, the third stage would be the responsibility of a country or countries other than Britain and France. In the original Anglo-French technical proposals presented at the start of the meeting, a British proposal for a third-stage engine, using hydrogen peroxide and kerosine, was illustrated (see Fig 1). This would have been a four-chamber design with each chamber pivoted about one axis for steering. With low thrust and the use of four chambers, very high nozzle expansion ratios (of the order of 1,000 : 1) would be possible without excessive chamber size or length.

The use of low thrust and thus low acceleration during the injection phase would have an important additional advantage in assisting the guidance of the satellite into an accurate orbit. This could possibly be particularly important in communication satellite

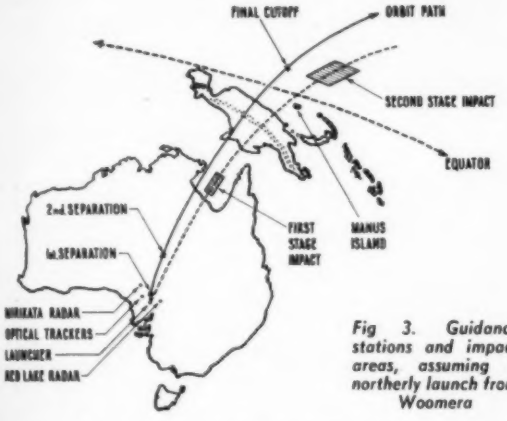


Fig 3. Guidance stations and impact areas, assuming a northerly launch from Woomera

applications, and, so far as was known, had not previously been advocated or exploited for satellite launching.

It was possible to meet the several different orbital requirements by exchanging satellite payload weight for propellant weight in the third stage, while maintaining the total third-stage weight at approximately 5,000lb. This meant that the tank volume would be altered to suit the particular orbital mission, allowing the remainder of the third stage, including engine and all equipment, to remain effectively unchanged.

In each of the propulsion stages, steering would be effected by swivelling the combustion chambers. An autopilot gyroscopic space reference, located in the third-stage electronics bay between the oxidant and fuel tanks, would maintain the roll angle constant and give the desired heading directions by sending control signals to the servo actuators which swivel the combustion chambers in the respective stages, changing over as the stages burn out and separate. The gyro reference heading is programmed from launch to cause the vehicle to follow a predetermined trajectory into orbit. Because of variations in engine thrust, wind disturbances and possible autopilot imperfections the vehicle will not follow the prescribed path exactly, and more accurate guidance is effected by correcting the basic heading programme by ground radio signals.

Among the important subsystems carried by the vehicle are telemetry (in each stage) to relay internal performance data to the ground; radio-guidance receiving equipment in the third stage; and range safety receivers in all stages able to receive destruct signals should the vehicle develop a fault and swerve off course.

Typical weights and dimensions for the three-stage vehicle are listed in the table. For particular cases, the fuel loads of the three stages can be varied to suit the powered trajectory.

Payload Capabilities Having first calculated the optimum stage characteristics it was found that restrictions would be imposed by considerations of range safety. The first and second stages must

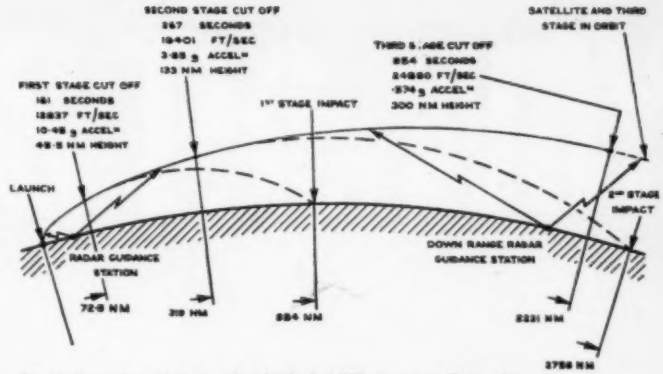


Fig 4. Launch trajectory of vehicle for 300 n.m. satellite orbit

fall into the sea and, in the case of a northward firing from Woomera, this would entail some loss in performance. In addition, the separation between stages and the final injection into orbit must occur at points on the trajectory appropriate to the siting of the radio guidance stations.

Within these restrictions the trajectory was optimized to enable the maximum payload to be placed in a desired orbit. The preferred trajectory for a 300-mile circular orbit is shown in Fig 4: this would also form the basis for the elliptical orbits (although a higher cut-off speed would then be required) and for the initial phase of the high circular orbit. The proposed location of guidance stations and impact areas for a northward firing from Woomera is shown in Fig 3.

DETAILS OF THREE-STAGE VEHICLE (BRITISH PROPOSAL)

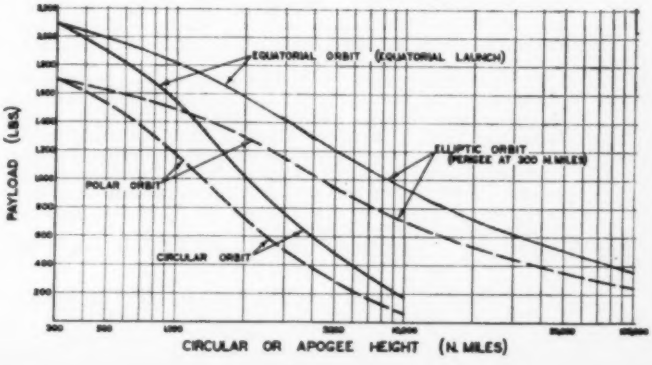
Take-off thrust	274,000lb (to be increased to 300,000lb)
Take-off weight	210,500lb
First-stage propellant weight	173,700lb
First-stage all-burnt weight	13,800lb
Second-stage propellant weight	15,500lb
Second-stage all-burnt weight	2,450lb
Third stage (for 300-mile circular orbit)	
propellant weight	2,800lb
all-burnt weight	500lb
Diameter of first stage	10ft
Diameter of second stage	4ft 6in
Diameter of third stage and over satellite fairings	4ft 6in
Length of first stage	60ft
Length of second stage	20ft
Length of third stage (300 n.m. orbit)	4ft 6in
Length of satellite over fairings (300 n.m. orbit)	12ft
Overall length of vehicle	97ft

Note: For a high (5,000 miles) circular orbit the third stage weights, assuming HTP/kerosine propellants, would be: propellant, 4,120lb; all-burnt weight less payload, 530lb.

The payload which can be placed into various orbits assuming Blue Streak engines rated at 137,000lb each are shown in Fig 5. These are "nominal" payloads in which some allowances are made for a growth in weight of the launching vehicle. To allow for unexpected contingencies, it might be prudent to assume that actual payloads would be 200lb less than the nominal values shown.

It can be seen that an equatorial orbit with an easterly launch offers a considerable increase in payload compared with that of a polar orbit. In practice the difference may be even larger because in the equatorial case it might be possible to avoid the loss in payload caused by ensuring that the first stage falls into the sea. This improvement would be about 100lb for the low circular orbit and about 50lb for the 5,000-miles circular orbit.

Fig 5. Nominal payloads in circular and elliptical orbits, assuming a third stage using HTP and kerosine



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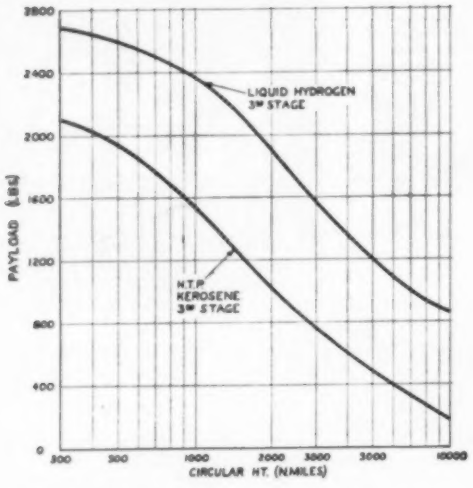


Fig 6. The effect of the introduction of a liquid hydrogen third stage for equatorial, circular orbits

Further Improvements in Payload With uprating of the Blue Streak engine to a total sea-level thrust of 300,000lb, improvements in payload of 250lb (low circular orbit) and 150lb (high circular orbit) would be obtained. In addition, the higher thrust would remove the restrictions on stage layouts caused by the confined impact areas in a polar launch, so that the equatorial-launch payload gains mentioned above would be obtained also in polar firings. The figures so far quoted do not take into account the thrust increase which would be expected in the second stage if an extension skirt surrounding the engines were adopted. This thrust augmenter should give increases in payload of 100lb and 50lb respectively for the two orbits mentioned. Thus nominal payloads of 2,550lb and 750lb could be placed in the 300-mile and 5,000-mile equatorial circles respectively.

A further possibility which has been examined is the replacement of the HTP/kerosine engine in the third stage by a liquid-hydrogen/liquid oxygen system. This development would involve a longer time-scale: the benefits which it would offer are indicated in Fig 6. This step would increase the two nominal payloads in the two orbits already considered to 3,150lb and 1,450lb.

Guidance Inertial guidance was rejected in favour of radar guidance on the grounds of weight. It was proposed to track and guide the first and second stages by using the existing range-safety radars installed at Woomera. These radars would feed the existing safety computer to which would be added equipment to enable it to perform the necessary guidance computations. The appropriate commands would then be transmitted to the vehicle.

The long powered trajectory would require a down-range station to track the third stage (see Fig 3). This station could use either a pencil-beam radar similar to that installed at Woomera or a radio interferometer system. The latter might offer advantages, particularly in the acquisition of the vehicle as it appeared over the horizon. Guidance into a high circular orbit would probably require a further tracking station.

Satellite Test Vehicles The final three development firings in the initial launch vehicle programme should all be capable of placing a satellite in orbit. These firings would carry satellite test vehicles, for the primary purpose of establishing the ability of the three-stage vehicle to inject a payload into orbit in a satisfactory manner. These satellites would be used to study such questions as environmental conditions affecting the satellite during the powered flight of the launch vehicle, problems of separation of the satellite from the third stage, and residual motion imparted to the satellite on separation.

As a secondary bonus the satellites could be used for a variety of purposes once in orbit. They might carry scientific instruments for space research or for the investigation of aspects of satellite technology. The latter might include questions of the behaviour of satellite stabilization and reference systems, power supplies, data storage and recovery systems, and the problems of heat balance in orbit. The choice of particular experiments in these fields would depend on the purposes for which the launching vehicle was subsequently to be exploited.

Development Programme The overall development programme envisaged is shown in Fig 2 on page 202. This illustrates the approximate time-scale for the major manufacturing and testing activities essential to the firing of ten vehicles, with launch-vehicle development complete by the end of 1965. There would be a parallel series of ground-launched tests of the French second stage, and flight experience with the third stage would be obtained in flights F3-F5. The first vehicle capable of launching a payload into orbit would be F6.

Not included in the outline programme illustrated is the large amount of supporting work, such as engine development, structural testing, F3 autopilot development (which demands an adequate structural dummy for vibration testing one year before the F3 firing date) and ground facilities.

Lead times between completion of manufacture and firing from Woomera have been assumed as eight months for the first stage and six months for the upper stages, using sea transport in the former case and air transport for the latter. Following manufacture and factory check-out, the trials programme in Europe would comprise essential extensive acceptance tests for vehicle stages, including static firings. Further checks of vehicle stages, including further static firings, would be made at Woomera together with checks of the complete vehicle system during the final preparation for launching.

The division of costs between the three rocket stages and other items, on the basis of the £70m programme, is as follows:—

Item	Percentage of Total	Approximate sum
First stage (British)	55	£38.5m
Second stage (French)	18	£12.6m
Third stage	9	£6.3m
Satellite test vehicles	10	£7.0m
Miscellaneous	8	£5.6m

As reported last week, the proposed approximate contributions from individual countries, on the same basis, is:—

Britain	£23,333,000	Belgium ...	£1,993,000
France	£14,399,000	Netherlands ...	£1,850,000
West Germany	£13,244,000	Switzerland ...	£1,582,000
Italy	£6,846,000	Denmark ...	£957,000
Spain	£2,063,000	Austria ...	£927,000
Sweden ...	£2,033,000	Norway ...	£773,000

During discussions of these costs at Strasbourg, Britain pointed out that, because of the work already carried out in the United Kingdom and the facilities and equipment available there, other countries could not be asked to undertake work connected with the first stage. The 55 per cent of the budget which was directed towards Blue Streak had been allocated to work already so far advanced that it could not, for reasons of economy, be transferred to another country. It was stated that Britain and France, in drawing up the proposed budget, had endeavoured to transfer as much work as possible—including for example all transport arrangements—to other countries. To divide the work differently might lengthen the time required and so increase the expense.

Belgian and Norwegian delegates suggested that it would be profitable if engineers and scientists from countries other than France and Britain could work as members of the French and British teams. The representatives of France and Britain agreed that this was desirable, and promised that their respective Governments would appeal to industry to co-operate in this.

Norway inquired also what proportion of the total effort envisaged was development work, and was told: first stage, 10-15 per cent (although the total from the beginning of the Blue Streak programme was 60-70 per cent); second stage, 60 per cent (including manufacture of prototype); third stage, 60-70 per cent; satellite test vehicles, 60-70 per cent or slightly more.

Answering a question from Denmark, Britain said that no country had been proposed for work on the third stage. The only wish was that it should be undertaken by a country or group of countries other than France. If there were several countries they might all be represented by some body which would choose its own location and operate under a central authority.

Mention was made at the conference of a "European telecommunications satellite organization" which, it was considered, might be a customer for the launch vehicles which the Strasbourg-proposed organization could produce and sell. Another customer might be the European Space Research Organization (ESRO), whose concern would be scientific satellites. Close co-operation between all three bodies was essential.

It was suggested that the proposed launch-vehicle organization should have a powerful and independent executive body, as was the case with the North Atlantic Treaty Organization. Gen Robert Aubinière of France said that the organization as envisaged was very close to the NATO system, where decisions were taken by a standing group. The Council supplied general instructions, drew up the budget, and allocated tasks, while the executive group was responsible for concluding contracts in accordance with general terms of reference, although its authority and independence were complete.

JCB LEADS THE WAY

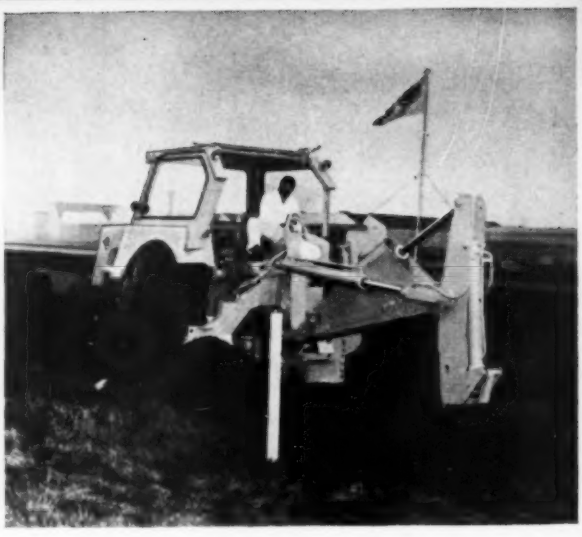
with the purchase of the first De Havilland Mark 8 Dove

J. C. Bamford (Excavators) Ltd are Europe's largest manufacturers of hydraulic excavators, and export some 43% of their production. Increased competition and rapidly changing markets abroad have emphasised the need for a fast, efficient means of transport to facilitate movement of executives and spares at very short notice.

JCB leads the way - others will follow

JCB ROCESTER STAFFS (UTTOXETER 3122 TELEX 3654

The time has come . . .



The time has come when J. C. BAMFORD (EXCAVATORS) LTD., of Rocester, Staffordshire, England, which in fifteen years has been built up by the enterprise of one man to a position of renown and leadership in the manufacture of earth-moving machines, cannot do without a Company-owned aircraft for urgent travel.

J. C. Bamford Excavators and Loaders are coming off the Rocester assembly line at 120 a month and 43 per cent go for export. This is now the largest business of its kind in Europe.

The close contact with users at widely scattered sites, on which Mr. J. C. Bamford insists, demands quicker, more flexible travel facilities than are possible by public transport.

He states that a privately owned aircraft with comprehensive equipment to ensure all-weather flying has become not merely justified but an essential factor in the further development of his sales and service.

After thorough competitive evaluation of all available aircraft in Europe and America, J. C. Bamford purchased the new Dove 8 Executive, de Havilland built and de Havilland powered. This will carry six passengers and two crew on practical stages of about 600 miles at 210 miles an hour.

DE HAVILLAND DOVE 8 EXECUTIVE AIRCRAFT

de Havilland Gipsy Queen 70 Mk.3 400 b.h.p. engines de Havilland Hydromatic three-blade propellers

The de Havilland Aircraft Co. Ltd., Hatfield, Herts. • *Member Company of the Hawker Siddeley Group*

Sport and Business

Private View BY P.P.O.

FIRST of a new series which will appear regularly in our "Sport and Business" section, this comment column is written by an active private pilot. His aim is to criticize constructively, to comment fairly—and amusingly—and to reflect current opinions in the world of light aviation. Readers' comments, and in particular those from club and private pilots, will be welcomed.

ONE of the nicest ways of using a light aeroplane is to take a trip to France. Apart from the food and other well-known joys, the welcome that you get is so delightful. If you are going to Paris, go to Beauvais for Customs; the genial smile from the brown face of M Crucifix is something to remember. The French Government has just given him the Legion of Honour, so don't forget to congratulate him.

Then fly on to Moiselles, which is only about 25km from the centre of Paris. Here, too, you are certain of being made to feel at home. And it is not everywhere that, when you are looking ruefully at an empty tobacco pouch, an old Frenchman looking rather like Père Dominic comes over and offers you his!

In France light flying and light aeroplane building are in a happy state. The French have a logical and commonsense way of dealing with restrictions, and they believe that everyone has equal rights to use the air.

Over here, yachting and small boat sailing are booming. Luckily for us there is no Ministry of Sailing. Private flying, like sailing, thrives on freedom. The more freedom you can give it, the more it will thrive. Just now it is relatively nearly dead in this country because the gentlemen at the Ministry are trying to legislate for the millionth chance which, most of us were taught at school, is impossible.

It is good that the ABAC and the PFA have been putting their heads together and have got out specifications for a light instructional aeroplane and a light tourer. This has been done before often enough, but the charm of their effort is in the recognition that, as far as light aircraft are concerned, there is a great deal we can learn from the automobile industry, and that it is not only the price of a new machine that matters, but what it costs to maintain and repair. This especially applies to flying schools where aeroplanes may expect rougher handling than in private hands. But aircraft are in themselves rather delicate tools, and any improvement in their "knockabout" utility is bound to make them more practical for the average private owner who, like the average motorist, just wants to get in and drive away.

On this subject of instructional aeroplanes, however, there is one important point to be remembered. Please let us not make them too easy to fly. I think that in some modern aircraft there is a lot of danger here. Recently in Germany I saw a nasty mess under a tarpaulin. It was the remains of a modern American four-seater which had just killed its four occupants quite thoroughly. I have flown this type; it is normally difficult to make it stall or spin, but just you try filling it up with four large businessmen and their bags, after a good lunch, and fly it carelessly, and then see what it may do to you. We all know that over-confidence is a disease which kills in the air. If modern aeroplanes are too easy to fly, I can see this disease being spread quite quickly.

Naturally, we don't want a machine that will break in every rough landing, but please let us have a machine for instruction that needs and rewards a little art in its flying. Then, when later we buy our own mounts, we shall be all the safer and better pilots.

Every pilot is certain sooner or later to get into a position when a steep turn near the ground is necessary with a heavily loaded machine. Then he may thank his lucky stars if accurate turns are a habit, and if he instinctively keeps his nose well down. High power, tarmac runways and insensitive controls are not good practice for boggy fields, overloaded aircraft and an engine that is not giving full revs.

I can hear the pundits saying that in these conditions no sensible pilot tries to take off. But what is he going to do if he doesn't? Tell Auntie Kate that she must get out and walk, or go home by train and come and fetch his machine later? In which case all his holiday plans will be spoilt. Everyone who uses an aeroplane for commonsense travel will be faced with this dilemma sooner or later, and the fact is that many will chance it.

"What is he going to do? Tell Auntie Kate she must get out and walk. . . ?"

Anyone who has been well trained will know instinctively if his machine is going to make it, or if the moment has come to cut the ignition and use the brakes and rudder. And he will also know that, having hoicked the machine off the ground, he must keep his wheels close to the ground to take full advantage of the cushion effect until he has gained flying speed to climb away.

The temptation to point the nose up and let the engine drag you out can be almost irresistible, and is safe enough with a powerful motor and a lightly loaded aircraft such as we may have had at the flying club. But if we have been properly trained we will know that this can be disastrous. However, by using all the airfield, and cutting the boundary fence fine, we can get away quite safely, and Auntie Kate will have her holiday after all.

FOUR REGIONAL DEALERS to be responsible for sales, spares and servicing of the Cessna range of light aircraft have been appointed by Airwork Services Ltd, the UK distributors for Cessna. The four are:—

(1) Midlands area—McAlpine Aviation, Luton Aerodrome.
(2) East Anglia—Mr N. A. Rogers, W. H. & J. Rogers (Engineers) Ltd, Gt Barford, Bedford.
(3) Northern England—Capt W. Westoby, Westair, Blackpool Flying School, Squire's Gate Airport, Blackpool.
(4) Scotland—Airwork Services Training, Perth Aerodrome.

The Cessna Sales Division of Airwork Services is shortly moving to Panshanger Aerodrome, where a new hangar and offices will house demonstration aircraft and spares and sales and servicing personnel. The Division will co-ordinate the Cessna sales efforts in this country and will continue to cover sales and servicing in the south of England.

PRODUCTION OF THE VICTA Air Tourer in Australia is to be subcontracted to a number of companies by Victa Consolidated Industries, in order to accelerate production and compete effectively with the Morane-Saulnier Rallye. The 95 h.p. Continental-powered version has now obtained its certificate of airworthiness, and the first all-metal production model is scheduled for delivery next June.

Fuselage construction will be concentrated at the Victa plant at Milperra, Chrysler Australia will build the tail unit, flaps and ailerons, and either Commonwealth Aircraft Corp or de Havilland will manufacture the wing ribs. Wheels, tyres, hydraulic disc brakes and fuel tanks will be supplied by the Dunlop Aviation Division at Victoria.

AWARDS FOR 1960 have been announced by the British Gliding Association. The winners are listed below and the presentation of the respective trophies will be made at the Gliding Ball at Londonderry House on March 10.

Wakefield Trophy. Peter Scott (Olympia 419), 298 miles from Nympsfield, Gloucestershire, to Cockburnspath, Berwickshire.
de Havilland Cup. G. J. Rondell (Olympia 2b), 29,100ft gain of height.

[*Continued on page 206*

The FN-333 Riviera all-metal four-seat amphibian, subject of a news item on this page, was designed originally by Nardi and is now in production by SIAI Marchetti. Power units for the two current models are Continental engines of 275 and 300 h.p. respectively. As the photographs show, the wing floats retract to form tip shapes during flight. Economical cruising speed is 159 m.p.h.

Sport and Business . . .

Manio Cup. A. J. Stone (Skylark 3b), 222-miles goal flight Lasham-Bridgnorth - Lasham.

Volk Cup. A. J. Stone (Skylark 3b), 222-miles out-and-return flight Lasham - Bridgnorth - Lasham.

California in England Trophy. Mrs Anne Burns (Skylark 3b), 27.6 m.p.h. over 300km triangle Lasham - Frome - Banbury - Lasham.

Douglas Trophy. Army Gliding Club: S. Morrison (Olympia 419), 168 miles from Lasham to near Bodmin; Capt E. G. Shepherd (Olympia 419), 157 miles from Lasham to Cromer, Norfolk; WO E. Stark (Skylark 3f), 250 miles from Odiham to Seaham, County Durham.

Frank Foster Trophy. Col A. J. Deane-Drummond (Skylark 3f), 44.3 m.p.h. over 100km triangle Lasham - Godalming - Pangbourne - Lasham.

Seager Cup. Cdr H. Dimock (T-42 Eagle), 13,500ft gain of height.

LAST MONDAY, February 13, the first Dove 8 in executive service was due to come up for its 100hr check. The aircraft, depicted in the accompanying photographs, is operated by J. C. Bamford (Excavators) Ltd on charter from their Swiss subsidiary company. It is equipped to a "regardless-of-expense" standard that any executive owner would envy. The argument for doing so is that it makes most-weather operation possible with only one pilot, which is sound-enough economics if utilization is sufficiently high to balance the saving of an additional crew salary against the fast depreciation of flight equipment.

A more practical argument, from the Bamford point of view, is that only-one-pilot permits an overall saving in weight and thus a small stretch in range—an important consideration for the long distances over which it is used and for which a long-range fuselage tank has been fitted. There seems reason to suspect also that fixed operating and overhead costs do not weigh too heavily with this firm against the value they expect to receive in return. The scale of the christening ceremony at Hatfield on January 24, Bamford's contribution to it, and the equipment and presentation of the Dove, all suggest that here is an executive aircraft which the operator wants known as a management tool—a functional symbol of status and vitality from experts in the export field.

Be that as it may, nearly 100hr have been covered in company service; and since the christening ceremony the Dove has been almost continuously away from home base. It has been "breaking-in new territory" visiting distributors in Lyons, Naples, Athens, Belgrade, Vienna, Zurich and elsewhere. It is hard to believe that D.H. could have been found a more rewarding first customer.

ILLUSTRATED ABOVE is the SIAI Marchetti FN-333 Riviera four-seat amphibian, the revised version of the original Nardi three-seater design of 1950. The long development of this type has included co-operation with Fiat and a design revision to meet the US Civil Aeronautics Regulations Part 3 in order to obtain an American type certificate. Italian and American type certificates were obtained in 1958. In March 1959 the manufacture of the FN-333 was transferred from Fiat to Marchetti and during that year further improvements to the aircraft were made and flight testing was continued. The design was re-examined to obtain certification for an increase in gross weight to 3,270lb and for a power increase to 320 h.p.

It is now intended to offer the production version of the aircraft in two models: (1) the Model B, powered by a 275 h.p. Continental IO-470 engine driving a two-blade propeller, and having a gross weight of 3,140lb; (2) Model C, powered by a 300 h.p. Continental IO-520 engine driving a three-blade propeller, at a gross weight of 3,270lb. A third version, the 320 h.p. Model D, should be available as soon as the engine receives the necessary FAA approval. The power units of the B and C models are interchangeable.

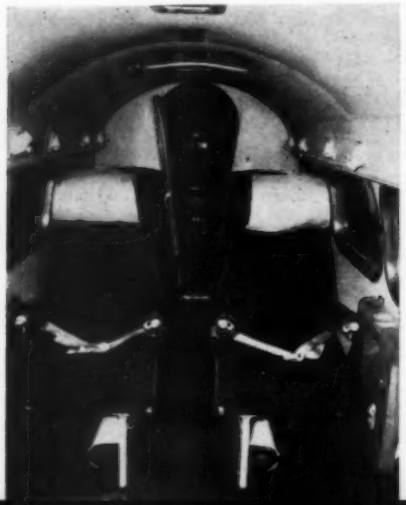
Dimensions and performance data include: span, 34ft; wing area, 163 sq ft; length, 20ft 8in; empty weight (Model B), 2,115lb, (Model C) 2,137lb; useful load (Model B) 1,025lb, (Model C) 1,133lb; cruising speed at 65 per cent power (162 h.p., 2,300 r.p.m.), 159 m.p.h. at 9,000ft; maximum speed at sea level, 177 m.p.h.

RETROSPECT

From "Flight" of February 18, 1911

Brooklands to Brighton: Mr. C. O. Morison has contemplated for some little time flying from Brooklands to Brighton, and on Wednesday last successfully accomplished his object. Starting about 4 o'clock on his Gnome-Bleriot, after making one circuit of the aerodrome, he rose very sharply to about 3,000 ft. and took a good line direct for Brighton. Flying in perfect form he reached his destination, alighting on the beach, after a turn over the sea, a little before five, having covered the distance well under the hour. In landing, the propeller and carriage were damaged.

Earlier in the day Mr. Graham-Gilmour had made a start for the same objective, but owing to engine trouble was not so fortunate as Mr. Morison.



(Left) The Bamford ensemble at Hatfield; Rolls-Royce for transport, excavator for exporting, and Dove 8 "Exporter" for exporting, too. The excavator is an efficient earth mover; the Dove, with its 210 m.p.h. cruise, an effective scene - shifter. (Right) The six-seat executive interior, in grey and white

FLYING THE CL-44

By G. T. McLEAN

THESE pithy and practical notes on handling the CL-44 are reprinted, by permission of Canadair Ltd, from the January-February issue of "Canadair Service News"—incidentally one of the most attractively produced publications of its kind we have seen. The author is G. T. ("Scotty") McLean, who joined the company in 1953 and has since been concerned with the flight-test programmes of the CL-28, CL-66 and CL-44. During the war, as an RCAF pilot, he was with Training Command and subsequently flew Mosquitoes in No 102 Sqn. After demobilization he was a KLM instrument instructor and, later, a civil aviation inspector in the Canadian Department of Transport.

THIS article has been written solely for the preliminary information of the pilots, both military and commercial, who will shortly be commanding this new and well-behaved aircraft. Pilots should appreciate the fact that only handling information will be dealt with and lengthy discussions on systems can be shelved temporarily for rainy day reading.

Ground Handling Deleting all the obvious taxying requirements applicable to most aircraft, there are some points connected with the CL-44 worthy of mention here. Pilots long accustomed to the many manœuvring problems of large aircraft are in for a pleasant surprise. The CL-44 is the easiest-taxying machine that this pilot has handled for many a year. But first, some words about starting [of the Rolls-Royce Tyne engines—Ed.].

Our present order of engine starting is 2-1-3-4. No 2 engine gearbox operates a cabin compressor, hydraulic pump and a constant-frequency a.c. generator; No 1 engine gearbox operates a hydraulic pump, a constant-frequency a.c. generator, and a variable frequency a.c. generator; No 3 engine gearbox drives a cabin compressor and a variable-frequency a.c. generator; and finally, No 4 engine gearbox drives one variable- and one constant-frequency a.c. generator. So much for the philosophy of the starting order.

Tyne engine starting is simple but, as with any turbine engine, requires strict adherence to approved procedures and careful control of starting temperatures. Initially, we use air to accelerate the h-p compressor to approximately 18 per cent h-p r.p.m. Engine control levers at this time are: power levers at Ground Idle; condition levers at Fuel Off. The appropriate condition lever is then moved to the START position. This provides correct starting fuel flow and ignition. The operator can expect an instant light-up and a continuous acceleration of both the h-p and l-p compressors. When the l-p compressor reaches 19 per cent the condition lever is moved to the lean-trim position. This provides a higher fuel-flow, and rapid acceleration can now be expected. It is at this point that t.g.t. [turbine gas temperature] must be closely watched. However, for those of you who might worry about the problem of "hot starts," we have a cunning arrangement whereby merely lifting the condition lever out of the lean-trim detent, reverses the action of the idling throttle valve and commences to cut fuel, thereby providing an easy method of control.

Now let's get moving. We have ascertained that, under most conditions, it is easier (and provides more positive control) to select all throttles to the Max Beta position for initial aircraft acceleration. Since you are selecting primarily a coarser propeller pitch with the throttle movement, you will be surprised to find your l-p r.p.m. drop from 75 per cent to 69.5 per cent. When the desired taxying speed has been reached, it is only necessary to retard the power levers towards Ground Idle to maintain this speed. From now on, by correct positioning of the throttles you can taxi slowly, quickly or backwards with ridiculous ease. Just remember, however, that a rearward movement of the aircraft can be arrested sharply by moving the power levers quickly from a reverse selection to Max Beta—undercarriages are not designed to take brake application in a rearward direction. Incidentally, selection of reverse entails nothing more than moving the power levers rearward from Ground Idle. You will also find that aircraft reaction to reverse selection is very positive, so therefore apply it gently from a static condition.

General Handling Take-off, engine and propeller checks have been deliberately omitted from this article, since these are easy and straightforward. In describing the take-off, we will assume a gross weight condition of 205,000lb and also an engine failure past V_1 speed. Since it is always nice to know whose hands are where, especially when considering an emergency situation, you must forgive the rather detailed sequence that follows.

The captain selects all power levers fully forward and, as the engines accelerate, releases the aircraft brakes. Concurrently, the co-pilot holds the control column forward of neutral and monitors engine instruments—especially torque gauges, for it is his primary function during the take-off roll to indicate verbally to the captain the first indication of an engine failure.

During the initial aircraft acceleration, directional control is maintained by use of the nosewheel steering until such time as the rudder becomes effective—usually around 50kt. Do not abandon the nosewheel control at this time, but rather maintain a loose contact so that a power failure at low speed can be dealt with instantly—directionally at least. As speed increases to 110kt, the captain should transfer his left hand to the control column with a verbal indication to the co-pilot that he is doing so. At speed V_1, the power levers are relinquished to the co-pilot. At book value V_R, a smart aft movement of the stick will result in the correct lift-off speed to attain V_2.

Let's analyse our take-off procedure. During the testing of an aircraft, one tries honestly to derive the maximum performance for the approved flight manual. I say "honestly," because the inserted figures must be within the capabilities of any knowledgeable pilot. We therefore prefer that the captain maintains contact with the power levers up to V_1 speed so that an engine failure before V_1—which means a stop—results in a smooth movement of all the throttles into Beta, rather than the familiar wild grab which has often resulted in some rather comical combinations of power.

The co-pilot has been appointed the failure-recognition expert for the simple reason that the captain will not immediately recognize a failure, even of the critical engine, at the higher V_{EF} speeds. Initially, the co-pilot also maintains a forward pressure

This impressive photograph of the CL-44D was taken on its first flight—November 16, 1960. Note the vortices from the D.H. propellers

on the stick to ensure a firm adhesion of the nosewheel with the runway. With a firm adhesion, a sudden failure of an outboard engine, even at low initial acceleration speeds, can be directionally dealt with by using the nosewheel steering control. It is therefore a safe procedure to maintain contact with the nosewheel control until through 110kt. Although our VMC (ground) is considerably below this figure, it stands to reason that a sudden decision to abort a take-off entails cutting power, applying brakes and keeping straight, and the last is much easier to accomplish with immediate use of the steering wheel.

An engine failure occurring during the latter part of the take-off roll produces no great immediate yawing effect. The engine will be producing some thrust even as the propeller is coarsening off, due to the action of the ADLS system. In most cases, a precious three seconds of runway length would be used up before the captain could establish that he had actually lost an engine; hence, the use of the co-pilot immediately to determine the failure. If take-off is continued, the procedure is the same as that previously described. Considering the 205,000lb weight condition, maintain some forward stick pressure until just before VR and then move the stick aft smartly at this speed (135kt) and climb away at V_2 (140kt). So much for take-off. Suffice to say the CL-44 is a well-behaved machine during critical or non-critical take-offs—providing, of course, you do it by the book.

Flight Manœuvring Continuing, there is no point in describing all possible and probable manœuvres; but there are, of course, some points worthy of discussion here. Firstly, you will be pleased with the ease of selection of engine power and the light but positive flight controls. You can, at the lower levels, quite easily change l-p r.p.m. by as low a value as one-tenth of 1 per cent. You can achieve the same minute control at the higher levels but, due to altitude effect, with a little less degree of ease. In all cases investigated, the cutting of high-pressure fuel on outboard engines produces highly acceptable aircraft reaction. The mechanical propeller-coarsening under these conditions is extremely effective and there is little need to jump-on flight controls to maintain aircraft equilibrium. Only in the vicinity of the critical airspeeds, and especially at the demonstrated VMC (air), is it necessary to move quickly on rudder and aileron.

Normal and accelerated stalls are docile enough for any handling requirements. However, in any configuration, and especially with power and full flap, continuing past the stall will eventually produce a very large wing-drop. This has no bearing on official stall tests of this aircraft, but is only mentioned here because we have to investigate all factors relating to any particular part of the flight envelope. It also has no bearing on our product—except a favourable one, because those of you who know the DC-3 may recall that going beyond the stall in that old timer finally produces a unique but uncomfortable view of the ground.

Since the free-floating type of main surface controls will be new to most of you and you might have some reservations about their efficiency, I could easily dispel all worries by the sweeping statement that there will be no noticeable difference. Actually, with regard to both longitudinal and directional control, there is very little I wish to mention until we get to the landing techniques. The Hobson feel unit, interconnected to the elevator circuit, seems to confuse some people (that is, the mechanics of the system, not the handling part). Suffice to say it is designed to restrict rapid movements of the elevator control (safety) and to provide the correct q-feel (handling) normally associated with airspeed changes. The loss of this system does not present any arduous handling problem to the pilot but, in effect, will produce a remarkably light stick. This is, of course, the direct opposite to the effect of losing the powered portion of control systems associated with other aircraft. The only penalty connected with the failure of the Hobson unit is a loss of good centring characteristics.

The lateral control reacts quite normally, but the method of employment causes the odd quizzical shaking of the head. Of course, there is nothing unnatural about the lateral movement of a control column. I would venture to say that as most of you trained on aircraft with sticks, you will find you adapt very quickly to our "bicycle handlebars." What you will find with all our controls, and especially with the aileron, is a certain tendency to over-control initially. To explain this I will discuss the lateral control only, since this appears to give new pilots the most trouble.

Even at high airspeeds the initial "break-out" of the aileron is light; that is, the force required to just start the control column moving. Since even a fraction of an inch of stick movement will produce a correspondingly slight change in the servo tab, lateral displacement results. Now it is in this small area of the overall lateral control that some pilots will tend to misuse this system. Specifically, they will tend continually to move the control column about its particular trimmed neutral point and this will produce lateral aircraft movement. Of course, a larger movement will immediately produce natural stick-force gradients. Prevention of the over-controlling tendency is only a matter of realizing that there is really very little play or stretching in this type of control system.

Landing We now come to the most interesting part of any flight; the approach, hold-off and "gentle" reunion with *terra firma*. Although there is nothing unconventional about the landing techniques with the CL-44 there are (as with all things) some tricks to the trade.

Basically there is no problem in landing this aircraft, but you must realize the reasons for the technique which I will describe. Looking at the elevator control, we have three servo tabs per elevator connected to the control column and one tab per elevator connected to the elevator trim wheel. To provide full elevator power for landing, it is therefore essential that all tabs be in harmony. In other words, nose-up trim should be applied just prior to rounding-out to ensure that longitudinal control is fully effective. In the case of landings at the most forward c.g. limit, full nose-up trim must be applied. For those of you who will immediately worry about a go-around with full trim selected, let me assure you that it is easily accomplished and with one-hand controllability.

One more thing. All screw-jacks in the control system are of the variable-ratio type. This means that towards the extremity of the control column movement there is a rapid build-up in servo tab application. Therefore, to achieve smooth touchdowns, the bicycle grip must be somewhere near your lap just prior to contact.

Finally, you must also realize that you have a considerable mass to rotate from the approach condition to the correct landing attitude and that the centre of rotation is a block behind you. For this reason you will appear to be high during the hold-off.

Now let's shoot one. Circuit and approach speeds are kept low. Aim during final to descend at 500 to 600ft/min and plan your airspeed and flap requirements so that there is a constant power-reduction as the runway is approached. At the correct height above the runway, rotate firmly and check slightly. Then hold off, ensuring that the control column comes back steadily to the fully aft position just at touchdown. As soon as possible, lower the nosewheel to the runway and then bring all power levers into Beta to provide as much propeller drag as you will require.

That's all there is to it, and the above technique will ensure smooth touchdowns. The important thing to remember is the procedures and to understand the reasons for employing a particular method.

I have purposely refrained from discussing emergency procedures. Actually, if you know your aircraft, systems-failures and breakdowns are automatically taken care of by an efficient crew. Any failures necessitating special handling by the pilot are easy and require only normal training procedures to ensure full knowledge.

In short, gentlemen, this is a solid, docile aircraft and a pleasure to fly, and to those of you who will shortly be in command of a CL-44—happy operations.

SWING-TAILPIECE

A FITTING postscript to the foregoing article on the CL-44 is the following note on the origin of the swing-tail principle, recently the subject of controversy. Like the article, it is from "Canadair Service News":—

"The original concept of the swing tail, as used in the CL-44D4, goes back to at least 1919, when a US patent was granted to a Mr Harold Balos of Bristol, England. In this patent was included the following paragraph:—

> "'This invention consists of a seaplane or aeroplane characterized by the provision of a hinged fuselage, whereby the rear section of the fuselage together with the tail of the machine can be folded so as to lie adjacent beneath or within the main plane or planes.'

"This patent was followed in 1922 by a design for a 'goods-carrying' aircraft by Mr H. P. Folland of Gloster Aircraft Company of England. This was described in *Flight* magazine of October 8, 1925, by an illustration with which went the following comment:—

> "'It is now several years ago that Mr H. P. Folland . . . designed a goods-carrier in which the rear portion of the fuselage was hinged and, when swung outwards, exposed the total cross-sectional area of the fuselage for the loading and unloading of goods. Hitherto, the idea has not been taken up, but it is obvious that it would be a very great advantage to be able to load bulky goods in this fashion and the time has now certainly come when some such type should be given more serious consideration.'

"Although no mention was made in the two extracts of the method of operation, it is most probable, in view of the relatively small size of the aircraft of that period, that manual operation and locking of the fuselage would have been used. In the CL-44D4, however, hydraulic actuation with electrical control provides rapid straightforward operation of the tail from a single position. . . ."

FLIGHT SYSTEM SURVEY

VOR/DMET in the Eumed Region

THE recent ICAO Limited Regional Air Navigation Meeting in Paris is reported to have decided on a detailed implementation plan for VOR and DMET in the Eumed region, including the location and frequencies of "550 facilities at approximately 380 locations." Some 69 VOR and 96 Tacan frequencies are available and the NATO military authorities have already specified their requirements for Tacan locations and frequencies. Tacan, which will provide the distance measuring element for the civil airlines short-range system, operates in the 1,000Mc/s band, close to certain military bands and those for both military and civil secondary radar.

It is essential that, for effective civil use of range and bearing information from Tacan and VOR, the two facilities should be located not more than 500ft apart in a terminal area and not more than 2,000ft apart on an airway. Because the distribution of military Tacan beacons is already planned and many are installed, co-location of this kind will be impossible in a great number of cases. When the two types of beacon are not already co-located, another Tacan cannot be added to the VOR if its frequency would interfere with that of existing Tacans—as it almost certainly would. The VOR cannot be resited because it must remain on the airway. The military authorities therefore have to be persuaded to move their beacon, an operation costing scores of thousands of pounds which they are likely to be extremely unwilling to undertake. The military Tacan beacons are sited partly for operational requirements, but also for domestic convenience on military sites or airfields.

In no instance in the United Kingdom will a Tacan beacon be properly co-located with its related VOR. For instance, Wallasey VOR is some distance from the Burtonwood Tacan with which it is theoretically paired. Ibsley VOR is some distance from Thorney Island Tacan, Dover VOR from Swingate Tacan and the projected VOR near Hull from its related Tacan near the East Coast. In Norway, Stavanger VOR is on the airfield and its related Tacan is 22 miles away. In addition to frequency difficulties in locating both VOR and Tacan beacons, there is the problem of finding suitably large, level sites. Once emplaced, the beacons and their related airways are almost rooted and a change of airway becomes, first, very expensive and, secondly, may be precluded by the difficulty of using the existing or any other frequency at a new site. There are also 46 air routes over non-territorial sea areas, which will not be covered at all.

Although pointed out from time to time, especially during the final stages of the ICAO meeting at Montreal when DMET was internationally adopted, the real, practical problems were not as well appreciated then as they came to be during the recent meeting in Paris. So much so that IATA, which formed a sizeable pressure group in favour of DMET last year, declared at Paris that unless VOR and Tacan beacons were properly co-located, DMET would "do more harm than good." Unless the beacons meet co-location criteria, say IATA, they will not be used by member airlines as part of the navigation system.

Some airlines, particularly KLM and BOAC, have flatly stated that they will not install DMET in their aircraft. BEA are as yet undecided. They stated a requirement for 35 additional Tacan beacons to fit the routes planned for the Trident in 1965, but frequency problems preclude provision of these beacons. The "central NATO area" is already saturated with Tacan, either planned or already installed. The Tacan network, planned for the military in the first place, will either have to be extensively altered or will be of little use to the airlines.

The ICAO plan for the United Kingdom calls for 26 VORs, four TVORs (plus six TVORs for BEA in the Scottish islands) and 16 Tacans. The cost of these beacons—and Tacan ground equipment will have to be bought from the US because it is not manufactured in Britain—will be very considerable. Once installed they will require regular flight checking, which will call for additional MoA calibration aircraft and great expense.

Viktor Runways

A NEW method of runway floodlighting has been tested during the past year at Malmö and Arlanda in Sweden and is now being examined by IATA and Swedish, British, German, Swiss and Portuguese civil authorities. Called System Viktor, the lighting involves illumination of the whole runway surface, the light being concentrated towards the centreline.

The new PanTronics DX10 ten-channel HF radio in its panel-mounted form with separate power supply. It has a transmitter power output of 50W and weighs less than 15lb (see news item below)

FAA May Test Dectra

APPARENTLY under pressure from PanAm, the Federal Aviation Agency is to evaluate Dectra as long-range aid on the north Atlantic. PanAm themselves produced a very favourable report following an evaluation of their own more than a year ago.

New HF Radio for Business Aircraft

ILLUSTRATED above is the new PanCom DX10 ten-channel HF radio, with power supply, which is now being marketed by the new company PanTronics Corporation of Fort Lauderdale, Florida. Vice-president and project engineer of the new company are respectively Ed Nilsson and Konrad K. Pangratz, both of whom were formerly with SunAir Electronics, well-known for their HF radios. Remote and panel-mounted versions with separate power supply are being produced for either 12V or 24V supplies. Each version will weigh less than 15lb and have 50W transmitter output power. The power supply is transistorized. Prices range from $990 to $1,290, including shock-mounts and crystals, and electric or manual aerial reels will be available. Deliveries are to begin next month.

Starfighter Electronics

FLIGHT control and navigation equipment for the F-104G is to be built in Europe as well as the airframe and engine. Telefunken, Philips and MBLE, the last-named a Belgian company, are to make the Autonetics Nasarr F.15A fire control radar; Eltro in Germany and Onde Delft in Holland will make the infra-red sight. Bell Telephone Manufacturing Co in Belgium will make the Position and Homing Indicator (designed by Computing Devices of Canada), air data computer and the Litton inertial navigation system. The autopilot will be by ACEC in Belgium and Honeywell in Germany. Teldix in Germany will provide PHI, Interaero the air data computer and Litton the inertial system. The last-named will also be made by Monroe in Holland. Van der Heem and Standard Elektrik Lorenz will make Tacan and radio equipment. Optical equipment will be made in Germany by AEG and in Belgium by OIP.

The Italian government is anxious to ensure that Italian electronic manufacturers take part in this and other NATO programmes.

International Research Symposium

FROM April 10 to 14 the Federal Aviation Agency is proposing to hold the first of a series of annual international symposiums on aviation research and development in order to allow an exchange of technical information. The session will be held at the National Aviation Facilities Experimental Center at Atlantic City and representatives from Britain, Canada, West Germany, Switzerland and a score of other nations will probably attend.

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The Argentine Aeronautical Mission has ordered three airborne Sarah transmitter/receivers, for installation in Beavers, and a quantity of personal beacons. This extends Sarah beacon coverage into the south-west Atlantic and brings the number of countries supplied up to 25.

A Decca type 424 airfield control radar has been installed at Coventry Baginton airfield. This provides search and precision approach to accompany the 5,300ft runway, cathode-ray direction finding and high- and low-intensity lighting recently completed there. The 424 at Coventry incorporates fully duplicated electronic units.

Bendix International have received an order from SAS and Swissair for Bendix DRA-12 Doppler radars and CPA-24 Doppler computers to equip their joint fleet of Douglas DC-8s and Convair 990s. The computer will indicate course, distance-to-go and distance left or right of track. Duplicated installations are being allowed for. TWA, United and Civil Air Transport already use Bendix Doppler and it is standard equipment for NATO Fiat G.91s.

Canadian Aviation Electronics have formed a West German subsidiary, C.A.E. Electronics Ltd to maintain the F-104G simulator to be supplied to Germany, Holland and Belgium during the next four years and also the CF-100 simulators now in service with the RCAF and Belgian air force. Two C.A.E. subsidiaries already operate in the US.

Straight and Level

Happy days, when a monkey could do all his thinking about British aviation just sitting on the cowl of a Sopwith Snipe's rotary Bentley. Humans used to fly first, and monkeys went for a ride afterwards, when everything was proved and tested. It's all rather different now

"Flight" photograph

THE portrait on the cover of an American flying magazine that has just come my way was, I am informed, "painted by Executive Portraits, a division of Portrait Group of Westport, Conn, which specializes in portraits of corporate executives and airplane owners . . ."

You, my readers, have no idea what I look like, have you? Perhaps you soon will. The only problem is how to get these Executive Portraits people to approach me without anyone getting the idea that I'd approached them first. I know what—I'll get my p.r.o. to have a word with their p.r.o. Of course, I shall refuse payment.

● At about half-past four last Monday afternoon, a few minutes after I had returned to the office after an excellent lunch, my telephone rang with unprecedented peremptoriness. "THAT YOU, BACON?"

It was the familiar voice of Sir Charles Boost. "Listen, old boy, this is *magnificent*! If you had any ideas at all about writing a column you would have published this weeks ago. Got your pencil?"

Boostie then read out to me a statement made recently by a British independent airline:—

It has already been demonstrated in practice that passengers, despite fare differentials, prefer to travel by the faster and up-to-date aircraft. In the intensely competitive conditions of today, these passengers must *be attracted by any company which is to pay its way.*

"How about that, eh, laddie? Isn't it what I've always been trying to drive into that dwarf brain of yours? The only thing the public wants is speed, speed, speed. Low fares mean nothing, the only thing people want is . . ."

"But, Boostie, isn't it the independents who have always talked about the need to develop the low-fare mass travel markets, and to . . ."

"Don't interrupt. And for heaven's sake don't give me all that stuff again, there's a good chap. I tell you, the only things that matter in air transport are high rates of re-equipment and depreciation, and fare increases. Passengers are *prepared* to pay high fares so that they can fly by the latest and fastest—you take it from me, laddie. The sooner we can give 'em rockets the better. Anyway, at least one of our independents has seen the light at last. How are you keeping, all right? Must have lunch one day soon. Cheerio."

● A moment later the phone rang again: "One other thing, old boy, on another subject. Aeroplanes must land fast and burn up."

● *"Limited pooling of aircraft [DC-8 and Boeing 707] parts by US and foreign air carriers will be allowed by the US Federal Aviation Agency under closely monitored contractual arrangements."*

So runs an FAA statement that arrived on my desk last week. The following thinks bubble was observed to rise from my head:—

Thinks: Good gracious, these Americans really are hot on pooling. I should have thought that an equipment-pooling arrangement was so obviously sensible that the FAA needn't bother to check up on it. But I suppose they feel that any commercial tie-up involving finance is *prima facie* open to abuse, and that the public interest demands a check. The FAA could be right.

Further thinks: Perhaps one of these days *our* legislators will get around to recognizing the need for checks on airline pooling—not so much on equipment pooling, which is obviously sensible, but on the obsession of our airline industry with revenue pooling, which is—well, I know how I think about *that*.

Final thinks: If the Minister does decide to check up on pooling, he will have shot my fox.

● Did you know that there were recognized hand signals by which a marshaller can tell a pilot to taxy backwards and turn right or left while taxying backwards? There are also signal panels that can be laid out on the ground to tell a pilot that his aircraft appears to have lost or damaged its left or right landing wheel.

I wonder whether one could lay out this relatively complex signal in time to warn a pilot effectively—still more whether the appropriate signals are kept handy at all airfields? They cannot be made up from the panels normally displayed in the signals area.

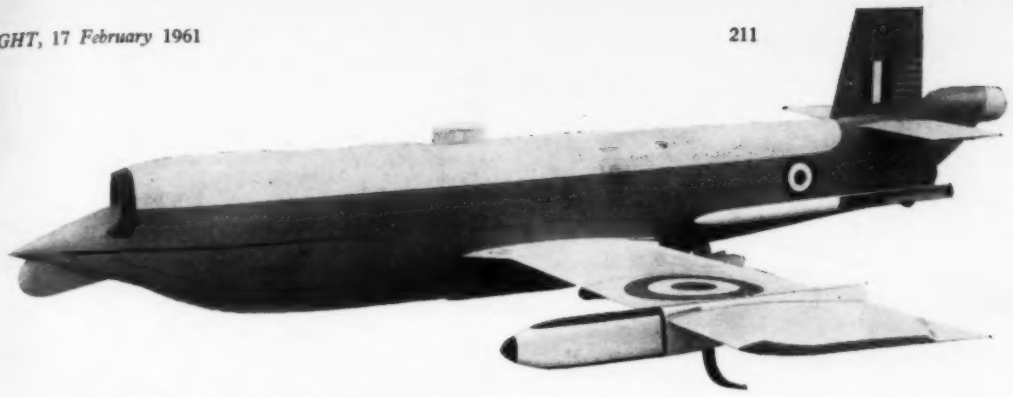
Incidentally, have you ever seen the red square in the signals area just plain red, without one or two yellow crossbars, to indicate that the airfield is entirely serviceable and you may land without "exercising caution"?

● I have just seen a copy of the English translation of a flying book that was awarded the Norwegian State Prize for the best children's book of the year. The English title is *Blue Two—Bale Out!*: the Norwegian is *Blå — Hopp Ut*.

Filled with stirring thoughts of shaggy Norsemen yelling "Blå, blå," as their long-ships sank beneath the waves, and excitedly supposing I had stumbled on the origin of "hop it," I was a little subdued to find that this last expression is, in fact, a Cockney corruption of "hop the twig," dating from 1912.

ROGER BACON

Something happens to a BEA stewardess between leaving London (left) and arriving at Moscow (right). It is, I think, something to do with a compromise between glamour and warmth. Let's get back to London, girls



JINDIVIK in Theory and Practice

THIS journal's review of the world's target and drone aircraft, published on December 23, demonstrated the immense variety of target vehicles and pilotless surveillance drones which are in intensive operation in the United States. There are now 22 distinct families of such vehicles, many of them highly sophisticated craft equipped with all manner of photographic and instrumentation systems, infra-red, radar and countermeasures equipment and a host of other devices. In contrast, if one excludes pilotless conversions of obsolescent military aeroplanes, there is only one such vehicle in the entire British Commonwealth: the Jindivik.

Shortly after the war the RAE issued a requirement for a jet-propelled target drone, and early in 1948 meetings were held between the Ministry of Supply and the Australian Department of Supply with a view to giving Australia the job of producing the vehicle required, to specification E.7/48. Eventually the specification was passed to the Government Aircraft Factory, at Fishermen's Bend, Melbourne, who have since been entirely responsible for design, development and manufacture.

As described in *Flight* for April 25, 1952, the GAF first built a piloted version named Pika (aboriginal "flier"). This flew in October 1949, and was of great assistance in enabling a direct check to be made on flight characteristics and the functioning of the control equipment. The first true target was the Jindivik ("hunted one") Mk 1, powered by an Armstrong Siddeley Adder ASA.1 rated at 1,050lb. The first was delivered to the embryonic range at Woomera in November 1951, and flew in August the following year. The original order for six for use at Woomera was later doubled, and the Jindivik Mk 1 became an effective operational target at the Weapons Research Establishment in the winter of 1952-53. Its principal systems included a three-axis autopilot incorporating some Elliott Bros (London) Ltd and German equipment, remote-control equipment built by GEC and a telemetry system by McMichael. All these systems were evolved at the RAE Farnborough.

In December 1953 GAF flew the Jindivik 2. The first true production version, the Mk 2 is powered by a Bristol Siddeley Viper ASV.3, rated at 1,640lb and appreciably lighter and simpler than the Adder. The whole aircraft was refined and simplified, and for the first time provision was made for special trials equipment to be carried. The airframe is fabricated from light-alloy sheet and standard sections. Although riveting is widely employed, stringers and secondary joints are almost entirely Redux-bonded, and extensive use is made of paper-honeycomb filling throughout the leading edges. The rear part of the fin (there is no rudder), together with the elevators, ailerons and simple flaps, have thin skins stabilized by axial fluting. Fuel is carried in a 63gal flexible cell in the centre fuselage above the wing and in integral wing tanks with a capacity of 16gal on either side. The flaps and landing skid are actuated pneumatically, but most services are electric, the engine driving a 6kW generator delivering at 27.5V.

After undergoing extensive functional tests a Jindivik required for a mission is wheeled out on its handling trolley, mounted on the cleverly designed trolley from which it takes off, towed round to the down-wind end of the runway and lined up for take-off by optical means. By this time the aircraft is in the hands of the team that will control and monitor it throughout its flight. At Woomera there is normally a "pilot," one or two "bats," and a minimum of about six tower operators, navigators and recording engineers.

Jindivik is not flown from a joystick box like an anti-tank missile, but via a radio-command system which biases the autopilot with a set of positive orders transmitted from buttons or switches on a large panel. The command signal is transmitted in the form of two audio tones, which frequency-modulate a carrier wave. Eight different tones are available, and each command is represented by a unique pair of tones. There are thus a total of 28 tonal pairs available, but only 24 are used to transmit command signals. Of these, 18 are used for normal flying, and have such forms as CLIMB, SLOW LEVEL, FAST LEVEL, TURN LEFT, and so forth; the remaining six signals are used to control the operation of special trials equipment. The airborne receiver translates these audio tones into direct commands. Since it normally rejects any signal other than a pair of tones, the receiver cannot respond to more than one command at any given time. For this reason, when the Jindivik is receiving command signals from, say, the pilot and one of the bats concurrently, it responds smoothly to the sampled demands from both.

An air hose is brought up to start the engine by direct air impingement on the turbine. The engine is then checked at 8,600 and 13,400 r.p.m. to assess response to its command circuit, the trolley being held back by a tie-strop anchored to the runway. For take-off, the strop connecting-pin is withdrawn and the Viper opened up to 13,400 r.p.m.

As the Jindivik accelerates down the centre of the runway, lateral disturbances, such as might be caused by a cross-wind, are sensed by a displacement gyro (17 in the cutaway drawing) mounted on the trolley which governs a servo-mechanism steering the nosewheel. During the run the aircraft is locked in a nose-down attitude, so that the three wheels of the trolley are held firmly on the ground. This is essential to the achievement, by braking the wheels, of the high retardation which would be necessary if the Jindivik were to fail to unstick cleanly at the point of take-off.

This point is reached at a speed of 110kt. Triggered by the airspeed circuit of the Jindivik, a "take-off" signal lowers the flaps, fires a brilliant flash bulb (1) on the front of the trolley, releases the lower bomb-slip catches (4) of the nose anchorage and puts the elevators in the fully up position. To assist the latter to rotate the aircraft, the tail is pulled down by the bungee cord (16), and the rising nose of the Jindivik extends the telescopic nose strut (6) to its fullest extent. When the strut reaches the limit of its travel it trips a microswitch which releases all three trolley struts, which are hinged and fold forwards under the pull of strong bungees (3). The same microswitch also triggers the circuit which puts on the Dunlop Maxaret brakes. The trolley quickly comes to rest (or is caught in a net if the runway is short), while the Jindivik climbs away. Complex though it sounds, the sequence works exeellently. Should anything go wrong, the pilot counts 3sec from seeing the 110kt flash and, if the drone is not by then fully airborne, he applies the brakes.

In most missions it is desirable to climb as rapidly as possible and thereafter fly a "race track" closed circuit at a typical jet operating height. It is possible to select an optimum climb condition by a single command signal, and at the desired height the Jindivik can be made to fly SLOW LEVEL or FAST LEVEL. It is then available, in the right place and with the right performance, either to act as a "wide open" target against which early R & D missiles may have a fair chance of success, or as an elusive and countermeasure-filled simulated enemy, better able to test the lethality of an operational or near-operational weapon. In former days a target merely had to be a piece of hardware put in the sky for gunners to shoot at. A modern target has to carry a wide array of trials equipment, and this will be referred to in greater detail later.

It is, of course, possible for the Jindivik to be destroyed in flight, either by a warhead or by direct impact, but in the vast majority of flights the drone is at all times under positive control and is brought back on to the runway. The final approach is quite a lengthy one, in the configuration LAND GLIDE at about 150kt. The two bats controllers are aligned upwind on the runway centreline, and each controls the Jindivik in either azimuth or elevation (but not both). Observing the approaching drone through graticule-equipped binoculars, they can maintain it exactly on the glide-

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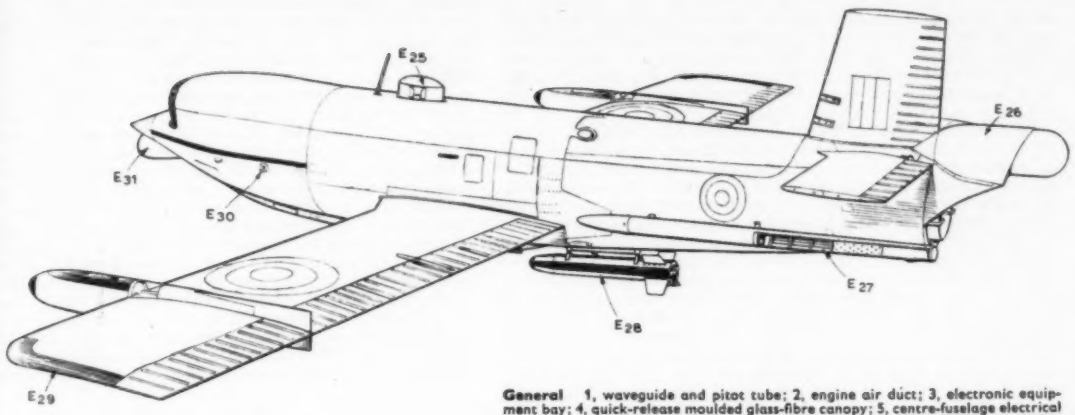
JINDIVIK in Theory and Practice . . .

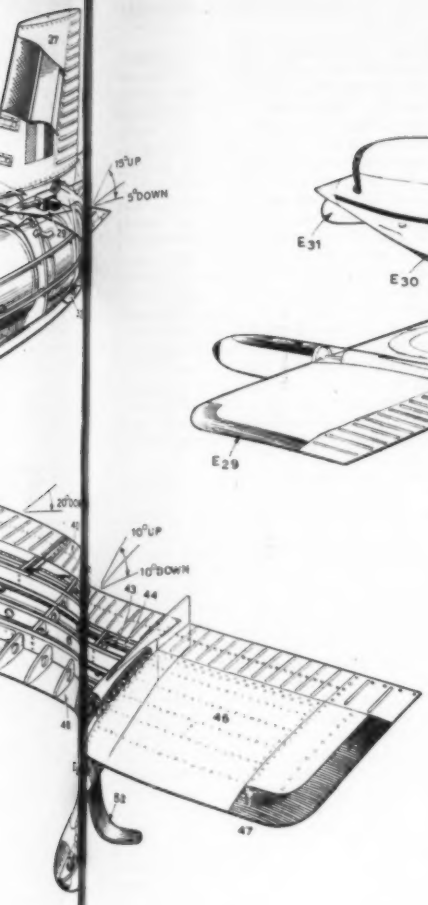
path, assisted by the pilot beside the runway near the touch-down point, who can also transmit command signals. The skid meets the runway at about 125kt, and the craft is held level as speed falls away. The skid is faced with strips of Stellite temperature-resisting steel. Near its trailing edge are shoes on either side which bite into the runway so that, by applying a few degrees of bank, the bats controllers can impart asymmetric drag for steering purposes. No braking parachute is employed. The tarmac runway surface at Evettsfield (Woomera) is temporarily melted by the skid, but solidifies without a mark. On this surface the skid-plate generally lasts about five landings. For recovery, the drone is merely lifted on to its handling trolley and towed away.

At least 100 Jindivik 2s have come off the line at Fishermen's Bend, and they form the bulk of the fleet operating from Evettsfield which has been of such inestimable value in the development of Bloodhound, Thunderbird, Seaslug, Firestreak and other weapons. In 1958 an order for Jindivik 2 was placed by the Royal Swedish Air Board, which has now been completed. At the time of this order it was stated in Stockholm that the contract was for ten aircraft, priced with ground equipment and spares at £A400,000. Jindivik has also been adopted by Britain, but in this case the story is a more protracted one, to which it is appropriate to return after discussing the more advanced Jindiviks now in production.

From the outset Jindivik was designed as a high-subsonic vehicle; and, since there has been no official request to do so, no attempt has been made to extend the performance boundary in a horizontal direction. In contrast, the GAF design and technical staffs, assisted by the Aeronautical Research Laboratories of the Australian Department of Supply, have sought ceaselessly for higher altitude performance. Such performance has been obtained by increasing both power and wing area.

An interim development machine designated Jindivik 2A was flown in 1958. It was the first Jindivik to be powered by the slightly more powerful Bristol Siddeley Viper 8, and instead of being fed from an NACA flush dorsal intake, the engine duct was extended forwards to a semi-pitot intake close above the nose. At the same time the span of the wings was increased by re-stressing the inboard portions and adding extension units at the tips. In production form this version is designated Jindivik 2B. First





General 1, waveguide and pitot tube; 2, engine air duct; 3, electronic equipment bay; 4, quick-release moulded glass-fibre canopy; 5, centre-fuselage electrical connections; 6, outer skin bonded to stringers; 7, fuel filler cap; 8, metal skin between fuel cell and fuselage structure; 9, 64gal crash-proof fuel cell surrounding intake duct; 10, fairing over tachometer system and generator; 11, Bristol Siddeley Viper 8 turbojet; 12, engine oil tank; 13, air bottle, 2,000lb/sq in; 14, air charging valve; 15, pneumatic blow-off valve; 16, access to engine governor, h-p cock, starter socket and switches for booster pump and cameras; 17, accessory gearbox; 18, fuel filter; 19, fuel pump; 20, throttle actuator; 21, flap and aileron operating jack; 22, flap-jack release valve; 23, engine trunnion mount; 24, jetpipe cooling-air intake; 25, jetpipe shroud; 26, tail unit; 27, honeycomb-stabilized leading edge (no rudder); 28, tailplane and elevators; 29, elevator servo-motor; 30, fairing over tail ballast; 31, nozzle area trimmer; 32, rubber tail bumper; 33, main-frame locating spigots; 34, wings joined on centreline; 35, longitudinal wing-locating spigot; 36, spanwise quick-release pin; 37, fuel transfer pipe; 38, fuel booster unit; 39, three-spar wing; 40, combined flap and airbrake (max angle 20°); 41, aileron; 42, aileron control rod; 43, piano hinge; 44, mass-balance; 45, integral tank, 16gal in each wing; 46, wing extension; 47, provision for aerial and navigation light; 48, provision for aerial; 49, inspection panel; 50, fuel transfer holes; 51, wing-root cuff; 52, landing skids; 53, trolley attachment; 54, parallel-link landing skid, stressed for 14ft/sec descent; 55, oleo-pneumatic shock strut; 56, touch-down sting retracts flaps, cuts engine and re-selects LAND GLIDE signal to prevent pitching during landing run; 57, stone guard; 58, trolley attachment; 59, nose ballast; 60, inverter cooling-air intake; 61, static vents

Take-Off Trolley 1, 110kt flash-bulb; 2, steerable nosewheel; 3, bungee cord; 4, electro-magnetic release for front arm; 5, electro-magnetic release for telescopic strut; 6, telescopic nose strut, 6in travel; 7, reservoir pull-away plug; 8, master switch for ground electric power; 9, disc brake with Maxaret anti-skid unit; 10, brake-priming pump lever; 11, ancillary brake equipment; 12, brake microswitch; 13, ground anchor strop; 14, rear pivot roller; 15, adjustable rear arm, pulled forward upon completion of nose-up rotation; 16, tail cable; 17, electric steering gyro; 18, ground safety lock; 19, oleo-pneumatic suspension; 20, damper; 21, mudguard; 22, Dunlop wheels; 23, friction-fit impact-absorption arm; 24, Type 100b inverter for gyro power; 25, 24V batteries; 26, gyro-power distribution box; 27, front-support hold-back rod; 28, steering servo-motor, German K.12; 29, splash guard; 30, shock-absorber pad for front arm; 31, servo-steering link

Equipment E1, telemetry junction box; E2, telemetry flight-instrument panel; E3, engine-speed transducer unit; E4, autopilot junction box; E5, roll unit; E6, receiving relay; E7, instrumentation relay; E8, 10cm navigation transponder; E9, selector unit; E10, 25V battery; E11, receiver unit; E12, control-equipment switch-gear; E13, auxiliary junction box; E14, transmitting unit; E15, pitch unit; E16, yaw unit; E17, access to autopilot and control master switches; E18, height lock; E19, transponder aerial on ventral centreline; E20, aerial for DESTRUCT command signal; E21, telemetry transmitter; E22, command receiver; E23, Ampor Mk 4 nacelles; E24, special-equipment bay, 12 cu ft; E25, camera calibration unit; E26, 10in Luneberg lens; E27, flare-heated IR source; E28, towed flare carrier; E29, glass-fibre tips incorporate microwave transponder aerials; E30, 3cm transponder aerials (three); E31, X-band transmitter, may be replaced by internal Luneberg lens

JINDIVIK 2B (Mk 102B)

Bristol Siddeley Viper 8, rated at 1,750lb thrust

Dimensions and weights Span, 25ft 7in; length, 23ft 4in; height (on skid), 6ft 3½in; gross wing area, 102 sq ft; t/c ratio, 6 per cent; structure, 886lb; power-plant, 628lb; fixed services, 169lb; control and navigation equipment, 272lb; Ampor Mk 4 nacelles, 80lb; trials equipment, 100lb (max, 280lb); fuel and oil, 783lb; gross weight, 2,918lb.

Performance Max speed, 605 m.p.h.; service ceiling, 55,500ft; operational endurance, with full allowances for climb, descent and landing, 40.5min; max endurance at 55,000ft, 66min; rate of climb at 40,000ft, 3,500 ft/min.

flown in October 1959, the 2B is currently being delivered to the WRE Woomera and to the United Kingdom. About to fly is the Jindivik 3A, powered by a Viper 11 and fitted with an improved autopilot, telemetry equipment and power supplies better suited to the substantially increased altitude conferred by the greater thrust. The Jindivik 3A will be available in three months' time, and the same aircraft with the Viper 8 will be known as the Jindivik 3B. At present the next stage in development will be the addition of a liquid-propellant rocket unit to achieve still further increase in altitude.

Trials Equipment

As already noted, a modern target drone is likely to be required to perform many functions, and the diversity and complexity of modern weapon systems is such that their development cannot be facilitated by the existence in the sky of a simple airframe at which they can be fired. Even discounting the fact that modern guided missiles are far from being identical, the drone characteristics necessary for early R & D trials are likely to be very different from those needed during squadron practice.

Possibly the most fundamental factor is that at all times the drone must be under positive control. The provision of a suitable radio-link poses few problems, but the need to keep the drone in radar contact under all weather conditions is likely to necessitate the addition of devices which can amplify the reflected radar signal or increase the target's radar cross-section. Of a similar nature is the requirement that the target shall be capable of simulating a typical piloted aeroplane against which defensive missiles can be tested. This again demands the addition of means for increasing the radar reflectivity.

The most direct method of accomplishing these requirements is to add one or more radar transponders. A transponder is, as its name suggests, a transmitting responder, which, upon receipt of a radio or radar signal, sends back an enhanced return. For general surveillance purposes S-band (10cm) radar is used, in order to achieve good performance at extreme range and in adverse weather conditions. At least two such transponders are fitted to give all-round cover for navigational purposes. Each is a small polythene top-hat shielding a broad-band dipole of cylindrical form. Several of the most important AI radars carried by intercepters work in the S-band, and when such aircraft operate against a Jindivik the target is provided with an additional transponder sensitive to this band. In this case the transponder must be tuned exactly to the wavelength of the AI set.

Transponders can be grouped into two principal types. Pulse transponders are triggered by the receipt of a pulse of the correct wavelength, and immediately send out a reply which, although representative of the received pulse, need not necessarily have

JINDIVIK in Theory and Practice . . .

either the same shape or frequency. Travelling-wave-tube transponders are merely amplifiers, sending out the received signals at a higher energy-level. The TWT transponder is not precisely tuned, and accordingly responds to practically any received signal in the appropriate band. The carefully tuned transponders matched to fighter radars are naturally of the pulse type.

Many of the most modern aircraft and missile radars operate on shorter wavelengths in the X-band (3cm). Provision is made in the Jindivik for an X-band receiver mounted flush on the underside of the nose fairing, immediately ahead of the landing skid. Up to three X-band transmitters can be carried, one on either side of the forward fuselage and one in the prominent fairing on the underside of the extreme nose. These seem likely to be replaced by TWT amplifiers, particularly for modern CW radars.

Luneberg lenses are in many respects more suitable than transponders for augmenting radar reflectivity. Design details of Luneberg lenses remain protected by security, but it is known that they are essentially spherical, semi-optical devices, broadly related to radar corner reflectors and hence to the rearward-facing light reflectors fitted to British road vehicles. Like the latter, the reflectivity is enhanced principally along a reciprocal path, so that they have little effect except close to the line joining the radar transmitter and the Luneberg lens. This fact has important repercussions in practice. During a trial of a semi-active homing missile, like Bloodhound and Thunderbird, a Luneberg lens could hardly be expected to offer much increase in radar cross-section, unless by sheer chance the missile happened to approach its target up the axis of the radar beam. A semi-active missile can approach its quarry from any direction, homing on to the radiation reflected by the target to all points of the compass.

A Luneberg Each End

On the other hand, Luneberg lenses are ideal wherever a directional enhanced reflection is required to return to the sender. For beam-riding missiles, for the acquisition of a target and for ground tracking they are ideal adjuncts. It is probable that one standard arrangement on the Jindivik 2B and 3A will be two 10in Luneberg lenses, one in the nose and the other in the tail. The former will be mounted inside the extreme nose in a bay vacated by repackaging the foremost telemetry boxes and removing the nose ballast weight. To enable this lens to "see" properly, the pitot tube will be moved to the starboard leading edge and the extreme nose made a glass-fibre moulding. In addition to providing enhanced signal strength within the forward hemisphere, this lens will be valuable while the Jindivik is approaching to land in poor visibility. The Luneberg lens in the tail (E26) will be mounted inside a hemispherical radome directly above the propelling nozzle and as far aft as possible. With both Lunebergs in place the Jindivik should have a radar cross-section in the X-band of 20 sq m from any direction. Radar reflectivity is generally proportional to the reciprocal of the square of the wavelength, and whereas a Luneberg lens is highly effective in the X-band, it would have to be of unacceptable dimensions to be effective at longer wavelengths. In the S-band, for example, Jindivik's 10in lens would give only 3.6 sq m.

Many important missiles, including the Firestreak, home on to the heat emitted by the engines of an enemy aeroplane. A little thought shows that in some cases the weapon could be equipped with a seeker cell sensitive to infra-red radiation of quite a short wavelength, so that it homes on to sources of high temperature like a turbojet or rocket exhaust. Alternatively, the homing head may have a cell designed to respond to longer wavelengths, such as are emitted by the hot metal around a jetpipe or an intake centrebody. The Jindivik has to simulate all such sources of heat.

The earliest and simplest arrangement was to hang an electric heater on either side of the extreme rear of the fuselage, looking like aft-facing car headlamps. Each contained a silica-housed electrical element with a rating of 1kW at 28V, in the centre of a reflector producing a direct polar heat pattern astern. Jindiviks at Woomera have frequently flown with three of these lamps installed. Jindivik 2Bs frequently also carry a cluster of IR flares on the rear fuselage. Each is filled with a typical flare composition plus a small proportion of iron or aluminium filings, and when lit provides direct IR radiation astern and leaves behind a hot trail.

In order to simulate the type of hot metal attractive to homing heads matched to longer wavelengths, what is known as a flare-heated source has been evolved (E27). This is virtually a long flare so arranged that its white-hot efflux plays on a battery of molybdenum vanes to give a sideways-looking polar pattern. Up to three of these FH sources can be carried to port or starboard of the rear fuselage, and fired on command. The ignition of twin and triple FH sources has been found to have no injurious effect on the Jindivik, and to provide a highly satisfactory heat source for missiles under development, even when the latter are fired from such a direction that portions of the Jindivik blank off much of the radiation.

In many trials it is desirable to provide an IR source remote from the Jindivik. One of the obvious trials which must be conducted is to assess the discrimination of a heat-homing missile, by providing two sources which to the seeker cell in the missile are not in a direct line one behind the other. As the missile approaches, its seeker cell will steer it to a point between the two sources—midway between, if the two sources are of equal power in radiating the wavelength to which the seeker cell is sensitive. The seeker "sees" within a cone of a certain included angle, perhaps of the order of 5° or less. As the missile streaks towards its target the two IR sources subtend a steadily increasing angle, and when this becomes equal to the limit of the missile's "vision" one or other source will suddenly disappear. At that moment the weapon's guidance and control systems impart a very powerful demand for manœuvre towards the remaining IR source. To see how missiles behave when this happens, Jindiviks have been flying at Woomera towing an IR source on the end of a cable, the complete configuration being so arranged that the vertical separation between the Jindivik and the tow is a maximum. A dispersed-source tow of this kind is visible in one of the illustrations (E28). This pattern weighs 60lb and contains four flares, and to provide the alternative source an additional battery of four flares would be ignited on the Jindivik.

A rather different configuration is required when a remote IR source is desired simply in order that the Jindivik may be preserved to fly again When conducting trials with live warheads, and during squadron practice, it is obviously essential that the missile shall be made to home on to something other than the drone. Even during trials without warheads, the accuracy of modern heat-homing weapons is such that direct impact is by no means unusual. Jindivik has been cleared to tow a group of flares astern on the end of a 300ft line. In such operations it is essential that, from the moment the missile seeker head locks-on to the target before it leaves the fighter, it steadfastly prefers the remote IR source to the jetpipe of the Jindivik.

In order to assess the behaviour of a missile during the closing moments of its interception, the drone has to carry cameras which can photograph the weapon throughout the trial. Such cameras have to operate at very high speed, owing to the immense rate of closure of modern weapons, and also need to have a wide angle of vision and superb definition. In the Jindivik 2 the cameras are mounted on each wingtip in what is known as a Mk 3 Ampor (airborne missile proximity optical recorder) pod. Each pod is like a miniature finned tip tank of 5.5in diameter. It contains one Wretar camera looking vertically upwards and another looking vertically downwards, each covering more than a complete hemisphere (actually 186° solid angle). The Jindivik 2B carries on the tips of the inner wings, inboard of the extension planes, Mk 4 Ampor pods, each twice as deep as the Mk 3 but having lower drag. Film is carried sufficient to cover two 5sec interceptions in one mission. It is desirable that it should always be possible to calculate the precise position of an intercepting missile with respect to the target, by inspection of the recording film. To assess inaccuracies introduced by aeroelastic deflection of the wing and camera pod, Jindiviks have flown with a calibrating mirror unit above the fuselage, with which the camera can photograph itself.

The Jindivik in Britain

As noted at the beginning of this article, targets and drones seem to have been neglected in Britain. To put it bluntly, we have tried to make do by converting obsolescent military aeroplanes, and in the long run this may well prove a mistaken economy. At least it was clear by 1958 that a proper target would have to be bought, and the most immediate requirement was to replace the Meteor U.15s used at Aberporth for Service Trials of air-to-air missiles and for a number of R & D firings.

For several reasons it was decided that the Jindivik should be used. Fundamentally, it is an excellent compromise vehicle, being easily handled in Service Trials yet large enough to carry all the special equipment needed during the development of surface-to-air weapons. A Ministry of Supply team left for the Government Aircraft Factories in January 1958, and spent some weeks conducting an intensive study of the complete system. Upon their return the Ministry decided to order ten Jindivik 2s, to be known as Jindivik Mk 102.

At the same time the Ministry brought in Fairey Aviation Ltd —as it then was—to study the Jindivik system in detail, design and manufacture modifications as necessary, manage assembly and functional testing of Jindiviks in the UK, and carry out trials at Llanbedr (the base for Aberporth targets) in conjunction with the RAE. The Ministry had arranged for Fairey to provide industrial support for the Jindivik system at the Paris Salon the year before, when Fairey had already come to an agreement with the GAF and exhibited a Jindivik as the official European agent.

The initial MoS order for ten Jindivik 102s was signed late in 1958. Fairey's Weapon Division at Heston, Middlesex, at once started the design and production of modifications to fit the target to UK requirements, and this work was covered by a contract

early in 1959. At the same time Fairey manufactured a quantity of handling equipment, started production of a weatherproofed launch trolley and designed and produced the bulk of the ground test equipment. Some important modifications were made to the targets themselves, to ensure complete safety during operations over populated areas. One modification conferred the ability to effect instant destruction under any circumstances.

During 1959 the order for Mk 102 targets was increased to 16, and the MoS also ordered 34 Mk 102B Jindiviks, these being the British counterpart to the Mk 2B. The first Mk 102 arrived in Britain in the autumn of 1958, but did not emerge from its modification and test programmes at Heston and White Waltham until January 1960. By this time arrangements for operating Jindivik from Llanbedr were complete. All the test gear had been installed, RAE operators trained, close liaison made with other Ministry contractors and the stage been reached at which any Jindivik arriving in Britain passed immediately into a pipeline of assembly, modification and test, to emerge as a target ready to take off from the runway at Llanbedr.

First flight of a Jindivik 102 took place in April 1960. When basic flight trials had been completed, consumption tests and performance check missions were flown using Avtur, and a number of range-indoctrination flights made before the aircraft was classed as operational last August. From the outset it had been realized that Cardigan Bay is a very different place from the Australian desert, and radar cover throughout the range has to be relied upon implicitly. General surveillance has been found to be adequate, but a forward-facing Luneberg lens is being added to obtain a satisfactory echo from precision-approach radar while on the glide path.

All 16 Jindivik Mk 102 targets have now been delivered. From Fishermen's Bend they were trucked to Laverton and flown by Air Charter Ltd to either Southend or Stansted. They were then taken by road to White Waltham and again by road to Llanbedr. For nearly a year Fairey, in their new guise as Fairey Engineering, have been engaged in handling the 34 more advanced 102Bs. White Waltham is dropping out of the picture, and assembly and conversion is being handled at Ringway. Only the first five of this batch were received as complete 2Bs; the remaining 29 are being flown in as bare Australian airframes, Fairey procuring the British autopilot, radio and most of the telemetry and trials equipment directly. The Bristol Siddeley Viper 8 is an allotment from the Ministry of Aviation, although Fairey handle its installation.

W. T. G.

Correspondence

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns. Names and addresses of writers, not for publication in detail, must in all cases accompany letters.

Crewing The Argosy

I FEEL compelled to write in regard to your January 6 reference to the Argosy aircraft and its FAA certification in the United States. On page 35 you state that the FAA has refused Riddle Airlines' request to operate the Argosy with a crew of two and "Hopes that a concession will be made in this case still appear to be high, and upon their realization may well depend future Argosy sales to operating-cost-conscious US freight operators."

If the operation of the Argosy is so financially critical that future sales will be influenced by the salary of an additional crew member, then the advantages of such an aeroplane are indeed questionable. The freighter cockpit layout is a perfect example of unrealistic design in regard to cockpit work-load and crew co-ordination.

When the 80,000lb rule was placed in effect, due to aircraft complexity, it was agreed (and still holds true) that an adequate yardstick was needed to determine when a flight engineer was required. The weight yardstick is the most logical and mandatory for proper design of a flight engineer's station.

Degree of complexity cannot be properly measured in the design stage, for what starts out on the drawing board to be a simple machine ends up on the flight line with many complex additions and modifications. Many times after an aircraft is placed in service additional changes are required which further increase the complexity.

Without such a yardstick, all aircraft, regardless of weight, would be designed for a two-pilot operation because of the obvious economic appeal, with a tendency to disregard safety. Safety is the very thing that prompted the 80,000lb rule in the United States in 1948. The Douglas DC-6 was certificated and flown with two pilots until it met with several fatal accidents and was grounded. Nearly all interested parties at the CAB hearings stated that there was a need for a technical specialist crew member in addition to the two pilots, because of complexity and work-load.

It would seem that there is now some retrogression in design-thinking, especially when we see the Argosy (which has 20 more dials, displays, controls, switches, etc, confronting the pilots than in a Boeing 707 layout, and 105 more than in the DC-8) being pushed for two-pilot operation. I can only say that people who advocate such a policy either don't understand the situation or are willing to forgo safety in the interests of economic gain.

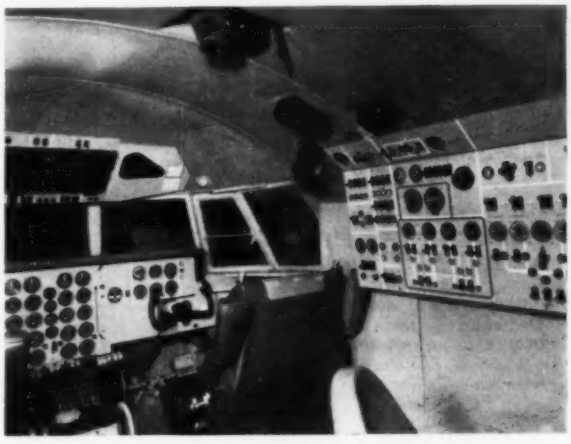
I think the ARB would do well to adopt a yardstick, such as the 80,000lb rule, for establishing guide-lines for manufacturers to follow. One of the first things a manufacturer is aware of in designing his aircraft is weight. With this yardstick he can then plan for, and properly design, an adequate flight-engineer station. In this manner, future transports will be designed from the beginning with a separate and complete flight engineer's station in mind. This will provide "built-in" crew co-ordination, realistic work-load distribution of duties, and maximum utilization of crew members in the interest of safety.

In the Argosy there is no provision for any of these, simply because it was not designed from the beginning for a flight engineer. Consequently, crew co-ordination will suffer, work-load distribution will be lopsided and working a hardship on the pilots, and the flight engineer will be given no tools to do his job. It would seem that the end product is designed to distract the pilots in every way possible from their job of flying and navigating the aircraft, and to make it as difficult as possible for the flight engineer satisfactorily to perform his job.

It is time that everyone in the airline industry started using safety as a means of making money, instead of using money and pressure to operate at a greater margin of profit and on the fringes of safety!

Washington, DC

GLENN B. IVERSON,
Vice-president Engineering, Flight Engineers' International Association



Mock-up of Argosy three-crew flight deck

[*We have invited Sir W. G. Armstrong Whitworth Aircraft Ltd to comment on the above letter. Their observations follow.—Ed.*]

The basic design philosophy of the Argosy was to produce a simple and efficient aircraft capable of safe and economic operation in freight and passenger roles. This we have done—to our own satisfaction and that of the regulatory bodies whose duty it is to see that aircraft meet certain requirements, of the pilots who will fly it, and of the companies who will operate it.

We are fully aware that the perfect aircraft has yet to be made, but we are confident enough of the soundness of the basic Argosy design to welcome constructive criticism. Only last month AWA created a precedent by handing over an Argosy to a team from the British Air Line Pilots' Association for a completely unrestricted assessment—the first time a British manufacturer has ever done so. The BALPA report (which will later be published) will be welcomed, although we know in advance that some of it may be critical of one or two points. This we are prepared to accept and this is the spirit in which we approach the Argosy. BALPA were, in fact, introduced to the aircraft at the drawing-board stage; and their advice, together with that of other pilots from all over the world, has been heeded in the design of the flight-deck, together with their comments on the integrity of all the major systems.

The FEIA letter is part of a controversy in which we, as manufacturers, have no wish to be involved. However, as the Argosy is the subject of most of the criticism, we feel we must state our position.

The basic Argosy, it is true, was designed for two-crew operation. This was because the aircraft was to use four Dart turbine engines

CORRESPONDENCE...

which are, as is well known, easier to manage than piston engines (thus rendering comparisons with the DC-6 invalid), and which had already proved entirely satisfactory for two-crew operation in the Viscount series.

In more than 2,500 hours of flying the Argosy in many parts of the world the safety of two-crew operation has been amply proved. This flying has involved extensive route-proving over Europe and the Middle East, visiting 29 different airfields operating full civil procedures. On these flights the two-man crews (test pilots initially unfamiliar with operating aircraft in and out of congested airfields) achieved a regularity which earned the congratulations of the national airline corporations.

While still advocating the 80,000lb weight rule as a "yardstick," the FEIA letter, in our submission, lays particular emphasis on the only true yardstick—cockpit work-load. This is the yardstick on which the Argosy cockpit design was based, and the result is an aircraft which can safely and efficiently be operated by a crew of two—a result with which the ARB (which has granted us full and unrestricted certificates) and the FAA (which has granted us a Type Certificate based on a flight manual stipulating a minimum crew of two pilots) agree.

However, although we are convinced of the safety and efficiency of two-crew operation, it is not a point over which we, as manufacturers, are prepared to cavil. If an operator desires it, or regulations demand it, a three-crew flight deck is available—having been designed and mocked-up in parallel with the two-crew layout.

Finally, FEIA's comment about the sales of the Argosy being influenced by the number of crew is based on a *Flight* statement, which is the magazine's own assessment of the situation. Obviously, from the operator's point of view, two-crew is more economical than three-crew operation; but we can prove that the economics of the aircraft are extremely attractive irrespective of the number of crew members.

Flying Rivets

YOUR reader ("Straight and Level," January 27) is right. Unpleasant facts can be most irritating. These particular facts were pointed out for the benefit of the sensitively underprivileged, who, though not able to realize the harm noise does them mentally and physically, are yet capable, through long experience of watching westerns on TV, of understanding the effect of a bullet!

Most other countries are beginning to appreciate that noise must be outlawed. The final report of the New York inquiry into noise and its effects reads:—

". . . there is sufficient conclusive evidence to prove that excessive noise is a menace to both physical and mental health. . . . Noise abatement should be considered as 'preventive medicine' rather than merely the elimination of an annoying nuisance."

Unfortunately those who suffer from noise are the same folk who are responsible for all that is good in civilization, and because of their intelligence and sensitivity they are loth to protest as vigorously as they are entitled to do.

It hardly seems fair that millions should suffer for the sake of the few, and in any case it would take less time for passengers to travel from Central London to the coast than it does to the present airport. Employees would enjoy the fresh sea air; and, for those who wish to remain, ample work would be available in the new industries which would immediately spring up in the space which would become available.

I feel quite sure many of your readers secretly agree with the logic of our arguments, although for obvious reasons they are unable to say so. But if any have sufficient courage to write, I should be pleased to hear from them.

6 Old Bond Street, London W1 JOHN CONNELL,
Hon Secretary, Noise Abatement Society

Disappearing Landmark

I HAVE read with interest Capt M. Somerton-Rayner's letter on the airship hangar built for the R.101 at Karachi Airport ("Disappearing Landmark," January 13). While it is true to say that the hangar was never used by the unfortunate R.101, I have recollections of one or two uses to which it was put. No 36 Squadron, RAF, stowed a complete squadron of Hawker Hornley aircraft in one corner when en route for Singapore in the early 1930s. No mean aircraft this either.

The maintenance crews who helped to service competitors in the London - Melbourne Air Race in October 1934 may well remember several hot sleepless nights under its roof and as a landmark I think I can say it was the goal of achievement for many of the inhabitants of the RAF Drigh Road Depot on their evening exercise walks, some three or four miles distant along the Malir Road. I believe the hangar could be seen up to 15 miles away across the flat surrounding desert scrub.

Thank you, Capt Somerton-Rayner, for reviving many old memories.

Bath, Som A. M. BROWN
(ex-RAF Karachi Aircraft Depot)

Smith-Barry Anecdotes Wanted

I AM preparing a short biography of Robert Smith-Barry, the founder of the Gosport system of flying instruction, and would be grateful for any anecdotes about him that your readers might care to send me.

The Savage Club, London SW1 F. D. TREDREY

THE INDUSTRY

Boulton Paul Aircraft Ltd announce the acquisition from Sheffield Twistdrill & Steel Co Ltd of the whole of the issue share capital of Accurate Screw Threads Ltd, Hednesford, Staffs.

Mr John Creek has been appointed deputy managing director of Fibreglass Ltd in addition to his present appointment as sales director. He joined the company in May 1952 as general sales manager and was made sales director in 1954.

Mr H. E. C. de Chassiron, managing director of D. Napier and Son Ltd, addressing the company's apprentices at the recent presentation of indentures and awards at Acton Town Hall. Guest speaker was Mr Geoffrey Dyson, chief national coach of the AAA, and the prize for the best trade apprentice went to R. E. H. Hitchinson

Following changes and new appointments, the board of Siebe Gorman and Co Ltd (acquired by the Fairey Co last September) is now as follows: Mr C. C. Vinson, chairman; Mr R. W. G. Davis, managing director; Dr L. Levy; Mr L. S. Dawkins and Mr M. H. W. Wells.

Smiths Aviation Division state that Kelvin-Kollsman cabin pressure control systems are being fitted in five D.H. Comet 4Cs for RAF Transport Command. Similar equipment has already been specified for D.H. Tridents of BEA and for the Short Belfast being built for the RAF. The system is based on the KS-69 cabin pressure control system developed by Kelvin's American associates, Kollsman Instrument Corporation, Elmhurst, New York. Control of cabin pressure is achieved by three series-connected, capsule-type monitor elements which convert pressure into electric signals. A motor-operated discharge valve trip mechanism and altitude switch are included in the system for abnormal or emergency conditions. Total weight of components forming the basic system is approximately 26½lb.

CIBA (A.R.L.) Ltd, Duxford, Cambs, have issued the first of a new series of data sheets on Aeroweb aluminium honeycomb core materials for lightweight structures. Titled *Production Information Sheet No 1*, this gives the maximum allowable pressures for bonding various types of Aeroweb core between skins.

Goodmans Industries Ltd have established three main agencies in the United Kingdom to handle their vibration test equipment on a sales and service basis. For the Midland area the agents are Hawnt & Co Ltd, 59 Moor Street, Birmingham 4; for Northern England, Farnell Instruments Ltd, Light Industrial Estate, York Road, Wetherby, Yorks; and for Scotland, A. R. Bolton & Co Ltd, Bankhead Drive, Sighthill, Edinburgh 11.

Four foam tenders were recently delivered to Hungary after being driven across Europe. The operation was a joint effort by the three manufacturers principally concerned—Pyrene, Thornycroft and Rolls-Royce—and followed a demonstration of fire-fighting equipment in 1959 arranged by the Pyrene agents in Hungary. One of the applications of the vehicles, built on a Thornycroft 4×4 chassis, powered by Rolls-Royce B.81 Mk 50F/1 engines, is for airfield emergencies.

Hydex, the low-twist nylon cloth coated with p.v.c. which was referred to in our Furnishing and Finishing issue of January 27 is manufactured by I.C.I. (Hyde) Ltd and supplied to John Cox & Son Ltd.

New managing director of Microcell Ltd and chairman of Palmer Aero Products Ltd: Mr C. G. Erlam, whose appointment to these posts has been announced by the controlling company, BTR Industries Ltd. The chairman of Microcell is Dr W. D. Scott and Mr J. J. Molins becomes assistant managing director. BTR have also announced the appointment of Mr P. L. Watson and Mr J. A. Hemingway to the board of Palmer Aero Products

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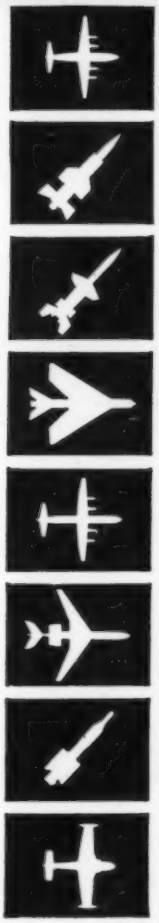

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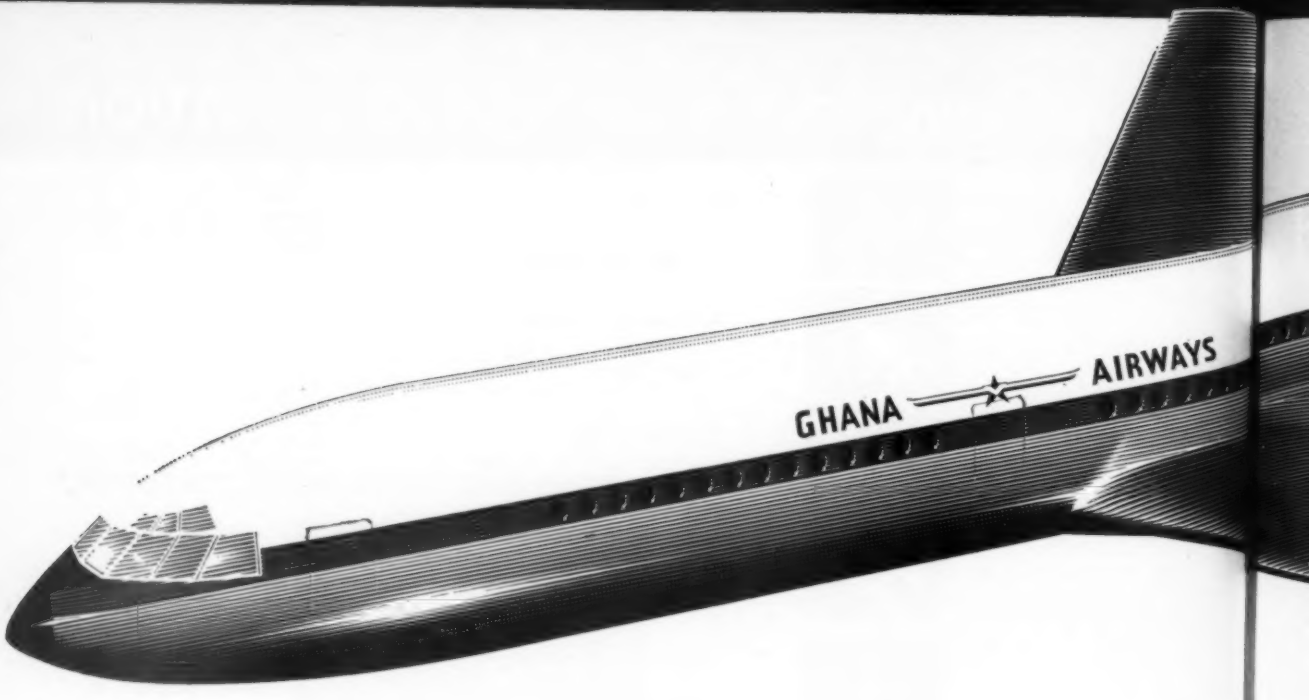
GHANA

SECOND GENERATION



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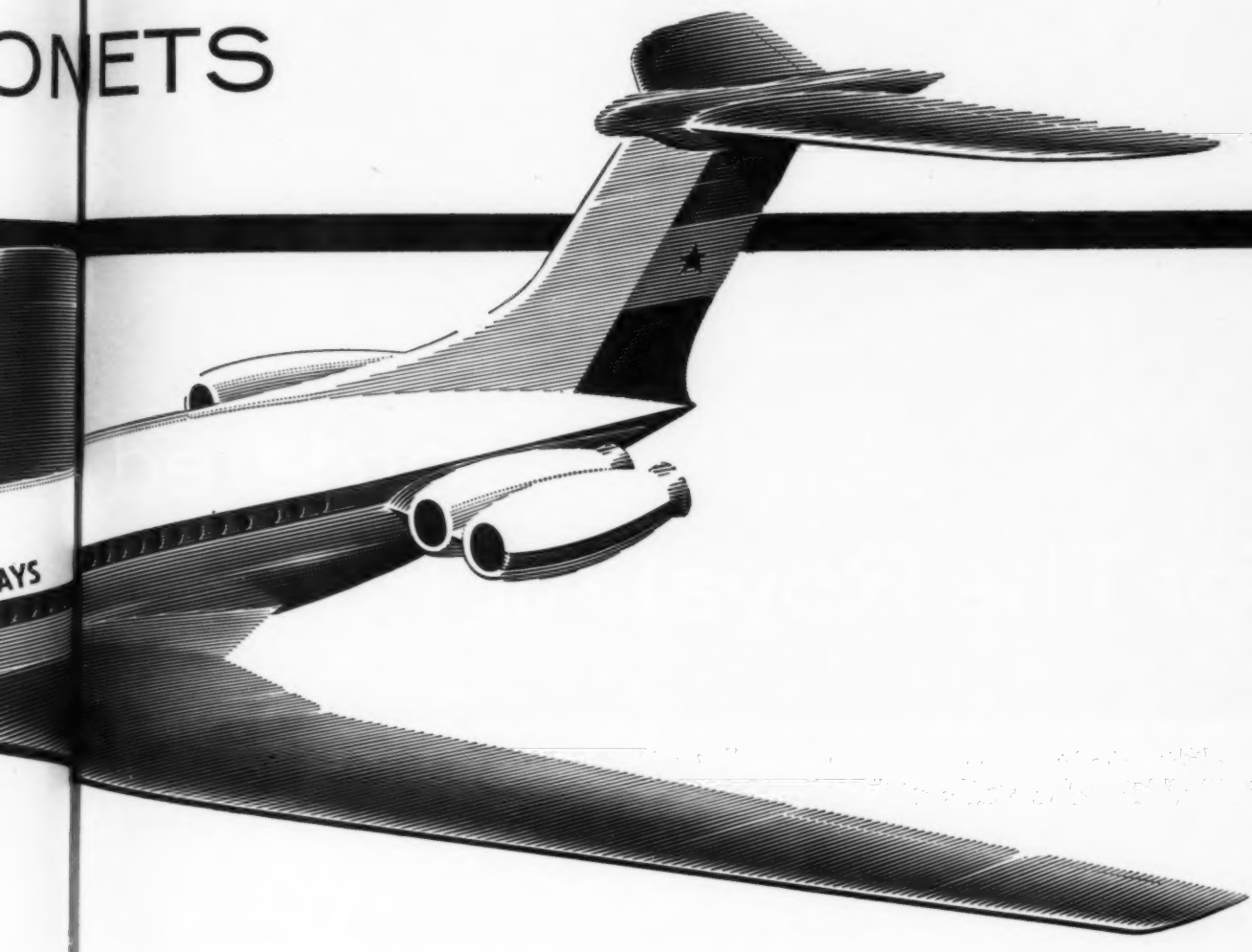

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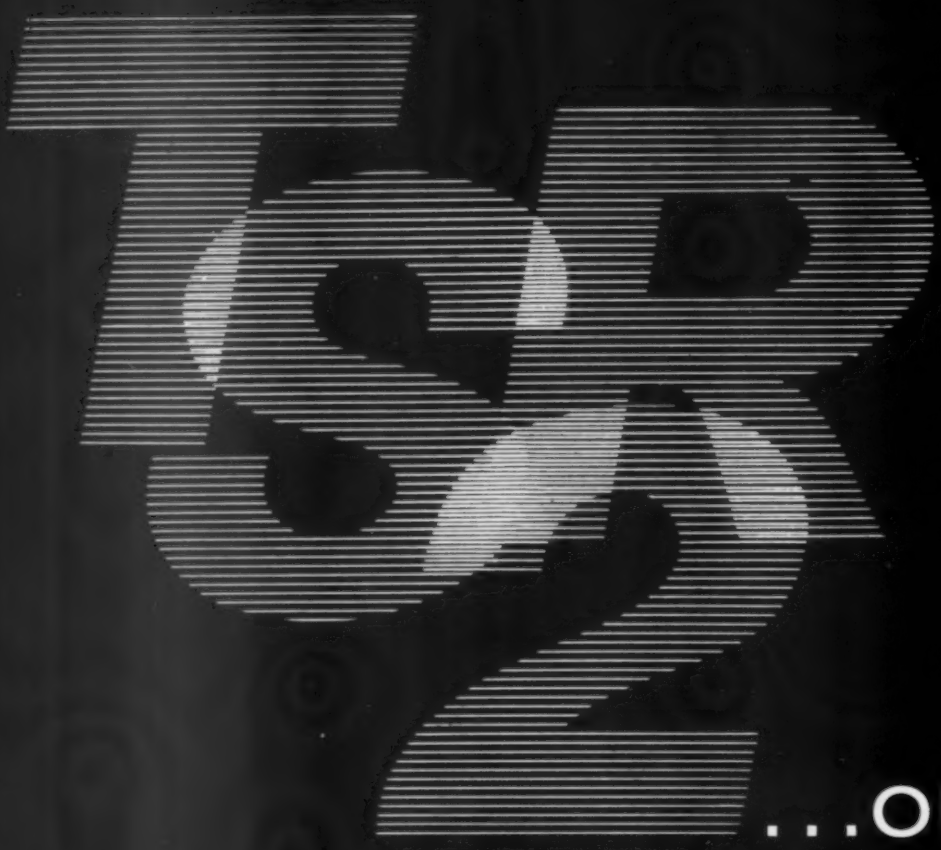

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During a recent speech, Britain's Minister of Defence, Mr. Harold Watkinson, said of TSR-2...

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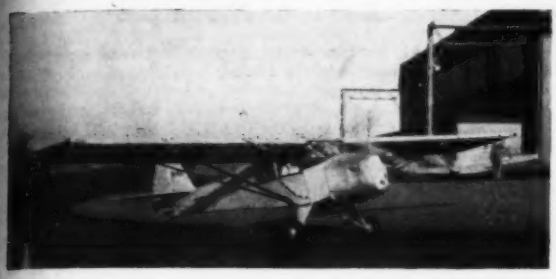
Malaya to Middle Wallop



BY CAPTAIN MICHAEL SOMERTON-RAYNER

Part Two

THIS is the second and concluding instalment (the first appeared a fortnight ago) of an Army Air Corps officer's account of a flight with his wife from Malaya to England in a 17-year-old Auster Mk 3 which had started life as an AOP aircraft on the Burma front. Here the story continues from Chittagong, East Pakistan.

OUT over the sea to Calcutta, across the mouth of the Ganges and the huge labyrinth of rivers. It was almost dark as we started to descend for Dum Dum, and the industrial haze made the field hard to find (the radio had again packed up) but just then a Dakota passed us on the port side, crossing our nose. I piled on the power and followed him down, and we landed neatly behind a Comet and in front of a Viscount. What a way to fly! We refuelled in line with all the professionals and went into town. Here we had two days' rest looking at the sights of Calcutta.

All too soon it was time to move on, and so the flight across India began to Gaya, a large airfield with all the aids, runway lights, terminal buildings and a staff to run it—but no aircraft. We were the first to land since March, and only the third that year. The airport is a diversion for Calcutta but is rarely required. On to Allahabad, Bhopal and Ahmedabad, places that bring nostalgia to old members of the Army who recall chukas before breakfast, but the old barracks, although still there, would now break the heart of any ex-Indian Army man.

At Allahabad the radio gave its final squawk, but again luck was with us for here is the Civil Air Training Centre, an organization run by the Indian Government to train airline pilots. Instruction was given on Chipmunks and HD.2s, Ansons and a Dakota, at the rate of 10 rupees per hour, i.e., £1 an hour even for the Dakota! There was one snag in this, however, the £1 rate applied only to those under 25 years of age. Older candidates had to pay the dreadful sum of £1 10s!

The centre let us have the use of workshops and we spent the morning cleaning plugs, filters and, in fact, carrying out a Check 2. We also traced the radio trouble to a faulty valve. After all this, we were ready for a further 30 hours.

Through India, leaving via Bhuj on the salt flats and leaving the green fields for the desert (for just how long we did not realize) and on to Karachi, where we committed a classic boob. It just goes to show what happens when soldiers fly.

Karachi cleared us downwind and finals, which struck me as strange because there was a military Bristol Freighter lined-up on the runway. One of those splendid conversations started that went like this;

"Have you got a Bristol Freighter on the runway?"

"No."

"Well there's one on the runway I'm trying to land on."

It transpired that we were over Mingaladon, north of Karachi, instead of on the other side. We were in a bit of a spot again because we were short of fuel, having flown from Allahabad. The intention was to collect fuel at Bhuj but, as was to happen a number of times from then on, no fuel had turned up and so we had continued, trusting that the forecast wind was correct. Luckily it was, but we did not have enough margin to go messing about in the haze over Karachi. Pride went out through the window and I asked for a steer, the final instruction being to look out for the airship hangar—which at long last, incidentally, is disappearing as the salvage men get to work.

The goof was entirely my fault, in not reading the names of airfields correctly, and was so stupid as to make me angry with myself.

Sand, sand and still more sand, and *why* had we painted the aircraft yellow? It was the finest of desert camouflage and half the world seemed to be desert. Grass was not to reappear until we reached France, and in the meantime it was just desert. At Jiwani the oil-company representative implored us to stay and rest for a few days in his "bungalow." We tied the Auster down on the sand, climbed into his jeep and drove to his bungalow which, he proudly informed us, was the best hut for 100 miles. Truly a justifiable claim—there was no other hut for 100 miles. We shared one glass between the three of us, and used the one spoon and two forks to have meals on a rota system. Supplies were brought in once a month, but every time a non-scheduled aircraft flew in it brought an extra parcel and we had brought some tins of food from Karachi. We would have liked to stay longer with Mr Manzoor for Jiwani is a peaceful spot, if you discount the fact that he slept on the verandah with a loaded rifle by his side to ward off the marauding tribesmen. But we had to push on as we were behind schedule.

Meteorology is an expensive toy, we decided. During the whole trip we never once received a correct forecast, the best being at Dijon where the met man walked across the room, climbed up on the radiator, looked out of the window and reported proudly "Fog." This we had noticed on our way from the town to the airfield. However, the forecast for Jiwani to Jask was the classic; "15-knot headwinds all the way; 4,000ft will give you the best chance," and so we decided on a fuel stop at Jask en route for Sharjah. Three and a half hours to Jask was the plan. We shot past the place in 2hr 5min with a 25-knot tailwind, and made Sharjah in 3hr 20min. How much is one of those lovely coloured met balloons?

Sharjah, a dreary one-night stand, was notable only for the first taste of British landing fees—twelve shillings for putting down on a bit of sand. Quite a lot when India, Pakistan and Burma only ever charged a shilling, even at the Internationals. It would have been better to have used the new civil field at Dibba, just a few miles away, but we did not know of its existence until later. Out of Sharjah and up into the oil kingdoms, where airstrips, built by the oil companies on exploration jaunts, abound all along the coast. A long detour around the coast via Tarif and up to Doha to avoid the water crossing. Although the direct track had been planned, everyone was now full of talk of the Dakota which had disappeared a few weeks earlier on the same run.

[*Continued overleaf*

Engineering development in Central India: an irrigation dam

Malaya to Middle Wallop . . .

Doha, a quick refuel, and on to Bahrein for a break of a few days to rest and look to the machine. Concern was being caused by the failure of the starboard tyre which first started to lose bits of tread on the wartime steel-plank runways in Burma. Now the effect of the sand was tearing the tread right off and great holes appeared in the tread through to the cords. No spares were available, but the RAF helped out with the aid of a "dough" gun which at least sealed up the holes, although the thing still looked vaguely like a catherine-wheel. The rest of the maintenance consisted of the usual plug-clean, filter-clean and going through the routine which had cured the misfiring troubles. After a very pleasant two days looking around this rich oil sheikhdom we once more set off, this time for Kuwait, where we stayed the night with Col and Mrs Pierce.

Before we left the next morning Col Pierce kindly insisted that we should have a good breakfast, and we certainly did. We did not, at the time, appreciate his remark that we didn't know when we would next eat.

We had been warned that the health authorities in Iraq were going to make things difficult for us, and so our plan to spend five days in the country was amended. We flew direct from Kuwait to Baghdad; a simple flight but made a little difficult by the amount of sand and dust in the air, which cut visibility to half-a-mile and caused us to miss our turning point at Al Diwaniyah. However, we turned on time only and relied on the sighting of the vee formed by the Tigris River and the State Railway to funnel us into Baghdad.

The atmosphere on landing at Baghdad was immediately ominous. The only people about were soldiers armed to the teeth, who looked idly at us. We switched off and climbed out but still no one came near, and so we walked over to the passenger waiting room. It was empty except for three soldiers in rough green uniform sitting at a long table. The middle one appeared to be an officer so I walked up and announced ourselves. We waited for fully three minutes whilst this worthy finished picking his teeth, and then he suddenly shouted, at a distance of only two feet, "I think you have no permission—why have you come?"

In vain we showed him our official clearance, but all it brought was further cries of "I think you have no permission." We tried politeness but that got us nowhere and then I lost my temper and shouted. That did it. The officer leapt to his feet and we were marched off to an inner room.

I decided that it was time to get in touch with the British Embassy, as the vision of 15 years in an Iraqi jail was appearing. As a result of this call, the Air Attaché, Wg Cdr Horsley, appeared very quickly. This produced results, inasmuch as the "no permission" man gave up his monologue and a health man took his place. It transpired that we had come from a cholera area and that we were to be put up in a local hospital for five days' quarantine. International certificates of vaccination were of no use: showing them produced only a shake of the head and "Five days."

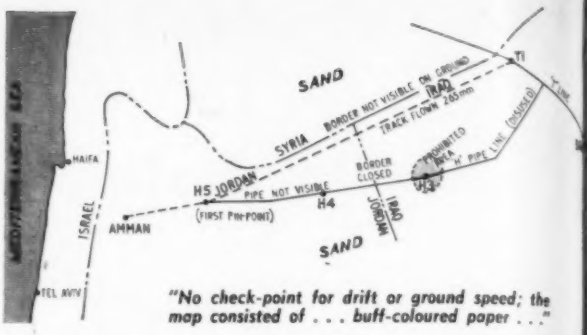
Take off—or Else

We were bundled into a vehicle and driven off at speed through the city to the hospital. We were getting desperate by this time but a certain transaction with the vehicle driver produced a promise to be back outside the hospital at 0630 the next morning. I heard for the first time in a foreign language the equivalent of that British Army guardroom phrase "Two live bodies sign here." We were the bodies. We settled down to a most uncomfortable night.

At 0630 we were up and peering through the window for our driver and, good man, he turned up only 15 minutes late with a release note. Our arrival at the airport caused some concern, but we hastily filed a flight plan, smiled at everyone, shook hands with anyone with a disengaged right hand, raced over to the aircraft, dragged it out and were airborne. It was one of those times when it did not take two hours. But our troubles were not over, for we could not make Amman, Jordan, in one hop, and we had to go to T.1 on the "T" pipeline to refuel. Here the fuel really let us down, as no 73-octane appeared (it was due to arrive three days later) and only 100 was available. To add to that, the officials of the airfield told us that we must leave the country immediately or return to Baghdad for a further five days.

There was no alternative, so we took on 100-octane fuel. The thought of the de Havilland warning letter of burning valve seats was seared into my brain for the next four hours. The met forecast also did not help, and indicated a headwind of 15kt, i.e., we did not have the range for the leg. Ina's dual stick was taken out and a four-gallon "flimsy" of fuel was carried between her knees. Our plot was to land in the desert and top-up.

Our first leg was 265 n.m. from T.1 to H.5: no pipeline to follow, just a straight flight over the open desert. We took off and simply steered the track, for experience had told me that the met was bound to be wrong. No check-point for drift or ground speed;



"No check-point for drift or ground speed; the map consisted of . . . buff-coloured paper . . ."

the map consisted of a piece of buff-coloured paper with two contours on it, but no hills were visible on the ground. For 3½ hours we droned on and on over the miles of flat sand.

Staring at the map and then peering out over the nose still produced no sign of H.5 and the road that ran through it. The compass looked a bit odd, and it needed a few minutes to realize that the wires on the grid ring had suddenly buckled into a peculiar S-pattern. Keeping the cord lined up now presented about twenty combinations (I assumed later that the heat must have made the wires expand). Suddenly my wife saw the H.5 pumping station. The dust being raised by a truck showed it up, and we proved to be just one mile right of track. Our groundspeed check indicated a tailwind again. Only 50-odd n.m. from here to Amman, and we did it comfortably without having to resort to our extra bit of fuel.

We now had some time to spare, and took a break of five days in sightseeing and visiting Jerusalem. We noted, incidentally, that Roman remains are so numerous in Jordan that they are used as door-stops. Praise must be given for the hospitality and help given us by the Jordan Air Force, who helped us with the aircraft maintenance and also took in hand our radio, which was never any good and hadn't been working since Sharjah. They really attacked it, and from that day on it really worked. It is now the only set of its type that has a range of eighty miles.

And so on to Cairo, although we were very sad to leave Jordan. Our route lay via Aqaba, to avoid flying over Israel and being unable to land in Egypt. Up to Mersa Matruh, seeing the battles of the Western desert unfold, although (apart from numerous old airstrips) nothing is visible today. On into El Adem, where the first mishap occurred—the tailwheel broke off. Luck was really with us for just next to us was a Canberra taking off for Idris (Tripoli). I remembered that the Army Air Corps used to have a Flight stationed at Idris, so I asked the pilot if he could scout around for a new tail-spring and stick it on any aircraft coming back within the next few days. At 10 a.m. next morning I was holding a new tail-spring!

We stayed at El Adem for two days while I fitted the spring and got on with other maintenance jobs. We then left for the final part of the trip to Berka No 2 near Benghazi, where the US Army have an aviation unit. Along the coast to Marble Arch, the airfield now closed but with fuel available at TAC.3, a level piece of sand near a US coastguard station. Then to Misurata, where the fuel failed to turn up again, and Idris, where our starboard tyre finally collapsed.

Fortunately we were able to obtain another tyre, and then we flew on to Tunis and over the sea to Cagliari—to arrive in the middle of an air display by the Italian Air Force. No one seemed to mind, and we received a great welcome and were treated to a very fine display of formation aerobatics by Thunderjets. Finally to France, the last foreign country and the European weather. At Dijon, we had a daily trip to the airfield to see if the fog would lift, which it did not for three days.

Whilst at Lyons we were treated to one of those sights that gladden the hearts of private pilots, and are guaranteed to give the Ministry of Aviation palpitations and a lunge to the restrictions rule book. Five light aircraft busy bashing the circuit, using the grass to the side of the runway, whilst a Caravelle and two Breguet airliners took off. No one turned a hair, no one was held up, and it was all perfectly safe.

Light aircraft appear to be understood in that country. When we arrived in the circuit at Le Bourget, we were cleared No 2 behind a Viscount and in front of a Caravelle and Constellation, and no one took the slightest notice. I wonder what London Airport's answer to that one is?

A gay weekend in Paris and then a run over the Channel to England, and to our first taste of British landing fees. Three days at Le Bourget in a heated hangar, price six shillings. One night stop at Lydd, £1 2s. Ah well, home sweet home to Middle Wallop and the Army Air Corps.

TCA and JP.4

An Airline's Defence of Wide-cut Fuel Questioned

BY J. W. RICKARD

SO at long last Trans-Canada Airlines have decided to risk coming out into the open with their case for JP.4 [*Flight*, January 13, page 51]. So far, so good; but whatever else it purports to be it is certainly not a reply to my article (*Ref 1*, overleaf), whose every point they have ignored.

Was it not of Miss Carmichael that Dr Johnson said: "When I tried to talk tight and close, she was all wiggle-waggle, and try as I might I could not force her to be categorical"? Quite obviously, TCA have no intention of being categorical either, this in view of the two very cleverly worded paragraphs (Nos 14 and 15) from which they deduce that controversy is futile on account of the situation being slightly complex. Others, however, *are* prepared to thread a way through the complexities in an attempt to arrive at the truth; and because of this it becomes necessary to refute yet again some of the statements which TCA (and others) keep on serving up in defence of a bad case.

I shall therefore consider under separate headings the technical points raised both in TCA's article and in Mr Dyment's separate statement prepared for the *Montreal Star* [*Flight*, January 13, page 51], but before doing so it is necessary to deal with one of the questions TCA ask of the "anti-JP.4 brigade."

They ask, implicitly, if we would ban all piston-engined flying. We would not. Our aim derives solely from the principle that each type of aircraft shall offer to the public the maximum amount of safety of which it is capable. To use JP.4 in a turbine-powered aircraft is a denial of this principle.

As for the standard of safety with gasoline being "acceptable" to the travelling public, this is probably so, though only because nothing better has been available. But now that we have the kerosine-fuelled transport, any burning to death of planeloads of people *through failure to use kerosine* is going to be considered —to make an understatement—most unacceptable.

The Crash-fire Risk TCA contradict themselves. In para 5 they state that they had no doubt of the superiority of kerosine in "one type of accident." In para 15 they say that they accept the conclusions of the NACA crash-fire programme which, they tell us, "demonstrated scientifically that enhanced crash-safety cannot be achieved through choice of fuel."

These NACA tests (*Ref 2*) are so often cited as evidence against kerosine that some elaboration is necessary at this point (I presume Mr Dyment is referring to the formation of fuel mist when he talks about fuel "splashing"). Agreed, if an aircraft after crashing is *enveloped* in fuel mist and this mist ignites, there will be a disastrous fire from which no one can hope to escape, regardless of the type of fuel. But the NACA tests were so staged as to produce deliberately the maximum amount of mist. This was done by breaching the tank leading edges with conveniently placed stanchions so as to leave large *forward-facing* orifices through which fuel was projected under the impetus of deceleration. Certainly this can occur in a real crash, but Mr Dyment is quite wrong to imply that it is typical of the majority of survivable crashes. How otherwise can be explained-away the fact that in at least five of the accidents listed in *Ref 1* (to which must now be added the Electra at La Guardia and the DC-8 at Idlewild), aircraft struck the ground, sometimes with violence, and caught fire, but that still substantial numbers of people were able to walk out?

Also, if ignition does not occur immediately, a quite moderate wind can render a mist innocuous within a few seconds, whereas the danger from spontaneous ignition and electrical arcing remains for a considerable time.

While spontaneous ignition, and ignition from burning engine and hydraulic oils, are probably the commonest causes of fuel fires in a crash, what justification has Mr Dyment for minimizing the dangers of electrical arcing by saying that "the electrical system goes out in a crash"? Crash switches, when fitted, do not always have the opportunity to work; and, as most accidents are unpremeditated, manual switching-out of the electrics is rarely possible. Sparking from abrasion on concrete surfaces is also prevalent in some crashes: the Comet landing at Madrid on its wheel-less undercarriage gave a spectacular demonstration of this.

Spontaneous Ignition It is correct to state that the spontaneous ignition temperature of JP.4 is higher than that of kerosine, but every authority which has tested the two fuels has come up with a different answer as to the magnitude of the difference. Mr Dyment, in order to make his case, quotes a figure of 222°C (400°F), whereas another authority puts the difference as low as 3.5°C (6°F) (*Ref 4*). In *Ref 1* I quoted the result of an investigation carried out by the Douglas Company (*Ref 5*). This showed a difference of 100°C (180°F) in favour of JP.4 under specified conditions. I believe this to be the very maximum order of difference to be found in a powerplant.

In any case, as Mr Dyment well knows, the NACA tests showed that engine-surface temperatures in a crash were high enough to ignite all fuels in current use. In the tests with jet-engined aircraft described in *Ref 3*, the JP.4 fuel caught fire without the slightest difficulty.

In connection with spontaneous ignition temperature, it is of interest to note that the Technical Department of Sabena, another JP.4-burning airline which claims to have made an exhaustive study of fuels, disagrees with TCA. They, Sabena, state that "for both fuels this (the s.i.t.) is situated at an identical point, i.e., 350°C."

Fuel Freeze-point When TCA state that the kerosine available in Canada in 1955 would have jeopardized safety and reliability, I must presume they are saying that a −40° freeze-point kerosine is unsuitable for their Viscount operations. Notwithstanding the much-vaunted Canadian winter, if they want us to believe this they will have to produce some evidence. On how many occasions have they had fuel temperatures fall to −40°?

Also it is a gross exaggeration to assert that time has shown the −40° kerosine to be inadequate for jet aircraft. Most US domestic operators use this fuel, and in their first 18 months of operation the lowest recorded fuel temperature at the completion of a trans-continental flight was −37°C (−34.5°F) (*Ref 6*).

Time has, however, confirmed that the −40° kerosine is unsuitable for long range over-water operation, especially with the slower jets, and to meet this situation the −50°C (−58°F) freeze-point kerosine was introduced some years ago.

JP.4 and the Oil Companies Are TCA unaware that JP.4 is an excellent refinery balancer? If it cannot be sold the industry will have a surplus of light ends on its hands, hence the inevitable downward trend in the price of JP.4. TCA need reminding that eminent fuel technologists of the Esso Export and Shell Companies have over the years made claims identical with those now being pressed by us of the "anti-JP.4 brigade" (*Ref 7*).

Engine Restarting Restarting an engine in flight can generally be accomplished a few seconds earlier with JP.4 than with kerosine, but this cannot make the slightest difference to the safety of the aircraft. Mr Dyment has gone out of his way to suggest that restarting may not be possible at all with kerosine. So far as British engines are concerned, this is nonsense. One does hear, however, that some non-British engines are reluctant to restart at altitude with kerosine; I have yet to learn that this has jeopardized safety, although it may well cause inconvenience. What such engines need, of course, is not JP.4 but further development.

Combustion TCA list the various manifestations of combustion-system troubles—e.g., carbon deposits, high component-temperatures, smoke generation—and then state that these things are worse with kerosine. British engines, which have been developed primarily on kerosine, do not noticeably suffer from these troubles. The development of many non-British engines, however, has been carried out on JP.4, with the result that, at their present stage of development, these engines *may* exhibit some of these maladies when running on kerosine. But if kerosine jeopardizes the reliability of an engine to the extent Mr Dyment claims, I would expect the engine type-certificate to quote two overhaul lives, a longer one for JP.4 and a shorter one for kerosine. I am not aware that this is so in the case of any engine.

To get this thing into perspective it is worth quoting the view of American Airlines, who have first-hand experience of American turbine engines (which TCA have not). I quote from *Ref 6*: "Since engine manufacturers had generally believed JP.4 would be the US commercial jet fuel, engine manufacturers had concentrated on that fuel and had little service experience with kerosine. But mechanically, jet engines apparently have tolerated whatever differences exist between kerosine and JP.4 with little distress."

Calorific Value Agreed, the calorific value per unit mass of JP.4 is higher than that of kerosine, but if TCA think the difference amounts to 1 per cent, then they are gravely mistaken and have not taken the trouble to ascertain the facts. According to information supplied by the Esso Company last year, average calorific values for North American kerosine and JP.4 are 18,600 BThU/lb and 18,700 BThU/lb respectively. This is a difference of 0.5 per cent, so their claimed seven-passenger advantage can be straightaway cut to three-and-a-half passengers. In order to achieve this advantage in switching from kerosine to JP.4, one would need a big jet aircraft flying for rather less than maximum range but with some 17,000 Imp gal of fuel aboard; passenger accommodation would be limited by weight. It would be interesting to know how often these circumstances arise in practice.

In this matter of payload and take-off weight, TCA contradict

TCA and JP.4 . . .

themselves. Firstly they are implying that, for a given a.u.w., an operator using JP.4 can put more passengers aboard; but in the next breath they are claiming increased safety through a saving in weight. They can't have their cake and eat it!

Fuel-system Icing By stating that kerosine carries more dissolved water than the gasolines, TCA yet again weaken their case. And yet we are asked to believe that they have made an exhaustive study of the fuel question. If only they had taken the trouble to consult any standard data on fuel properties, they would have made the discovery that it is JP.4 that holds the greater quantity of water in solution (not that this will affect the practical case). If they are so confident about the superiority of JP.4 in this respect, it would be as well to remind them that the USAF (which was a long time waking up to this problem) has had not only numerous incidents due to fuel-system icing, but has actually *lost* several aircraft because of it: and all this on JP.4.

All turbine aircraft need to be fitted with fuel heaters regardless of the fuel they use. Are TCA willing to throw away their heaters because they use JP.4?

Fuel Cleanliness All fuels, and kerosine in particular, need most careful filtration before being put into an aircraft. This requirement is well understood and is being successfully met the world over.

In-flight Fires The idea that a JP.4 fire is safer than a kerosine one is certainly amusing, although unintelligible. Would Mr Dyment please be more specific?

Tank Explosion Hazard and Static Discharge This article would appear to offer an opportunity to clear up once and for all the bogy of the fuel tank explosion hazard. Sir William Hildred has stated that JP.4 is less explosive than aviation gasoline. This is not true. Because JP.4 is less volatile, it requires a higher temperature range to make it explosive, and this range is of such an order that it will be encountered more frequently than that required for a gasoline explosion. This does not mean that gasoline is safe (the loss of a TWA Constellation over Italy in 1959 has been attributed to fuel tank explosion), but only that explosions are more liable to occur with JP.4. In support of this I quote two extracts from the report of an American organization which has done research into lightning hazards (*Ref 8*): "*. . . Only JP.4 was used in the initial sequence [of tests] to check hot-spot ignition of fuels, as it was conveniently in the explosive range at room temperature. . . . Gasoline held at 0°C (32°F) did not explode; however, JP.4 did explode at this temperature. . . .*"

Also, extra special precautions need to be taken during the ground handling and storage of JP.4 (*Ref 4*). There have been numerous cases of JP.4 tank explosions in aircraft on the ground, in ground-storage installations, and in sea-going tankers. In flight, at least one tip tank of JP.4 has been exploded. Gasoline explosions have been proportionately fewer, although, as stated above, one Constellation is believed to have been lost as a result of tank explosion, and a gasoline-filled tip tank has been exploded by lightning strike in flight.

From the crash standpoint, JP.4 fuel/air mixtures in a tank will often be in the explosive range and near stoichiometric, particularly during landing. This means there will be a distinct possibility of a violent explosion the moment fire breaks out: this in addition to the hazard due to rapid flame-spread across the liquid-fuel spillage.

Kerosine will only be explosive at such temperatures as may be obtained during tropical operation. But even in the tropics, all landings (except, possibly, those on very short haul work) will be made with kerosine below the weak limit of the explosive envelope.

All the above information is obtained from basic fuel inflammability data (*Ref 1*, corrected version). If Sir William Hildred and Mr Dyment maintain that these data do not apply to the conditions obtaining in an aircraft tank, then would they please say why, and also present some *evidence* in support?

Considering now the question of static-electricity build-up in flight, I do not see how the fuel itself, regardless of its type, can become charged from an external source, considering that it is contained within a metal envelope. But when the airframe discharges static (or if a tank is struck by lightning) if this occurs in the region of a badly designed tank-vent, there is indeed a possibility of explosion when the tank contains an explosive vapour/air mixture. This is more likely to occur with JP.4 than with kerosine, for reasons already explained. Once again, refer to report *Ref 8*.

The only other known source of static build-up in flight occurs as a result of the release of dissolved air from the fuel during a climb to altitude. This process of de-aeration results in the electrostatic charging of the fuel surface. The question arises as to whether this charge is sufficient to cause a spark discharge before it can leak away through the tank walls.

To answer this question, investigators set out to measure the magnitude of the charge (*Ref 9*). Kerosine and JP.4 were tested, both drawn from stock, and it was concluded, guardedly, that the possibility of spark discharge appeared to be remote in the practical case. The investigators drew no distinction between the two fuels.

Regarding static build-up during ground refuelling, it was once believed that kerosine did generate more static than did JP.4, but the most recent research (e.g., that carried out by Shell in this country) has shown that there is no difference between the two fuels in this respect.

Fuel Spillage Great attention must be paid in design to ensure that leaking inflammable fluids are drained overboard as easily as possible. It cannot be concluded that leaking kerosine is more likely to cause a fire than is JP.4. If the latter fuel is let loose in quantity, only its lighter ends will evaporate; the kerosine-like residue will be left behind to "crawl." If the evaporated light ends come into contact with an ignition source they may well cause something worse than a straightforward fire—namely, an explosion.

Mr Dyment cites the loss of the prototype Valiant as a kerosine hazard. As this was a military aircraft I am not in possession of all the details, but I feel quite sure that that accident does not illustrate the "crawling" tendency of kerosine. As I understand it, the aircraft did not explode, but caught fire during engine restarting following the release of an unusually large quantity of fuel through the engine. This fuel somehow got into a non-fire zone and ignited. What makes Mr Dyment so sure that, had the fuel been JP.4, it would all have evaporated rapidly and harmlessly?

Conclusion I think I have shown that TCA's case for JP.4 does not exist. But let us suppose for a moment that it does. Would it not then be possible to design and operate an aircraft so as to accommodate the alleged shortcomings of kerosine? What is clearly not possible is to allow for the case of the unpremeditated crash (and these occur with monotonous regularity) where much fuel is at large: here the best design in the world cannot prevent it from getting at the ignition sources. And this consideration takes us right back to that television demonstration staged by Lord Brabazon and myself for the benefit of those "eight million sweaty night-caps."

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(5) Fuels for Turbine Transports: *SAE Journal*, June 1956.

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(7) Proceedings of the Aviation Turbine Fuel Meeting in Stockholm, Sweden, September 23-24, 1957.

(8) Investigation of Lightning Hazards to Aircraft Fuel Tanks: *Lightning and Transients Report No. 333*, December 1956.

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FORTHCOMING EVENTS

Feb 21. RAeS: "New Metallic Materials of Construction," by Dr N. P. Inglis.
Feb 21-23. International Airline Navigators Council: 11th Annual Convention, New York.
Feb 23. Aerodrome Owners Association: a.g.m. and Dinner.
Feb 24. BritIRE (South Midlands Section): "Design Aspects and Characteristics of Long-distance Waveguide Communication Systems," by A. E. Karbowiak.
Mar 1. RAeS Graduates' and Students' Section: a.g.m.
Mar 1. Society of Instrument Technology (South Yorkshire Section): "High-speed Instruments for Combustion Research," by A. E. Pengelly.
Mar 3. RAeS Rotorcraft Section: "Helicopter Approach Aids," by H. W. Mitchell and S. G. Lennox.
Mar 7. RAeS Astronautics and Guided Flight Section: "Guided Weapon Control Equipment," by John Dent.
Mar 8. RAeS (main lecture at Chester Branch): "Low-speed Problems of High-speed Aircraft," by A. Spence and D. Lean.
Mar 8. Kronfeld Club: Photographic Exhibition, and talk by F. N. Slingsby.
Mar 9. Radar and Electronics Association: "Air Traffic Control," by Arnold Field.
Mar 10. British Gliding Association: Annual Ball.
Mar 11. British Gliding Association: Annual General Meeting.
Mar 13. RAeS Historical Group: "Evolution of Transport Aircraft," by P. W. Brooks.
Mar 15. Kronfeld Club: "Collision Experiments with Wire Barrage Weapons," by Gp Capt Kent.

RAeS Branch Fixtures (to Feb. 24): Feb. 22, *Hatfield*, "Space Research," by Prof H. S. W. Massey.

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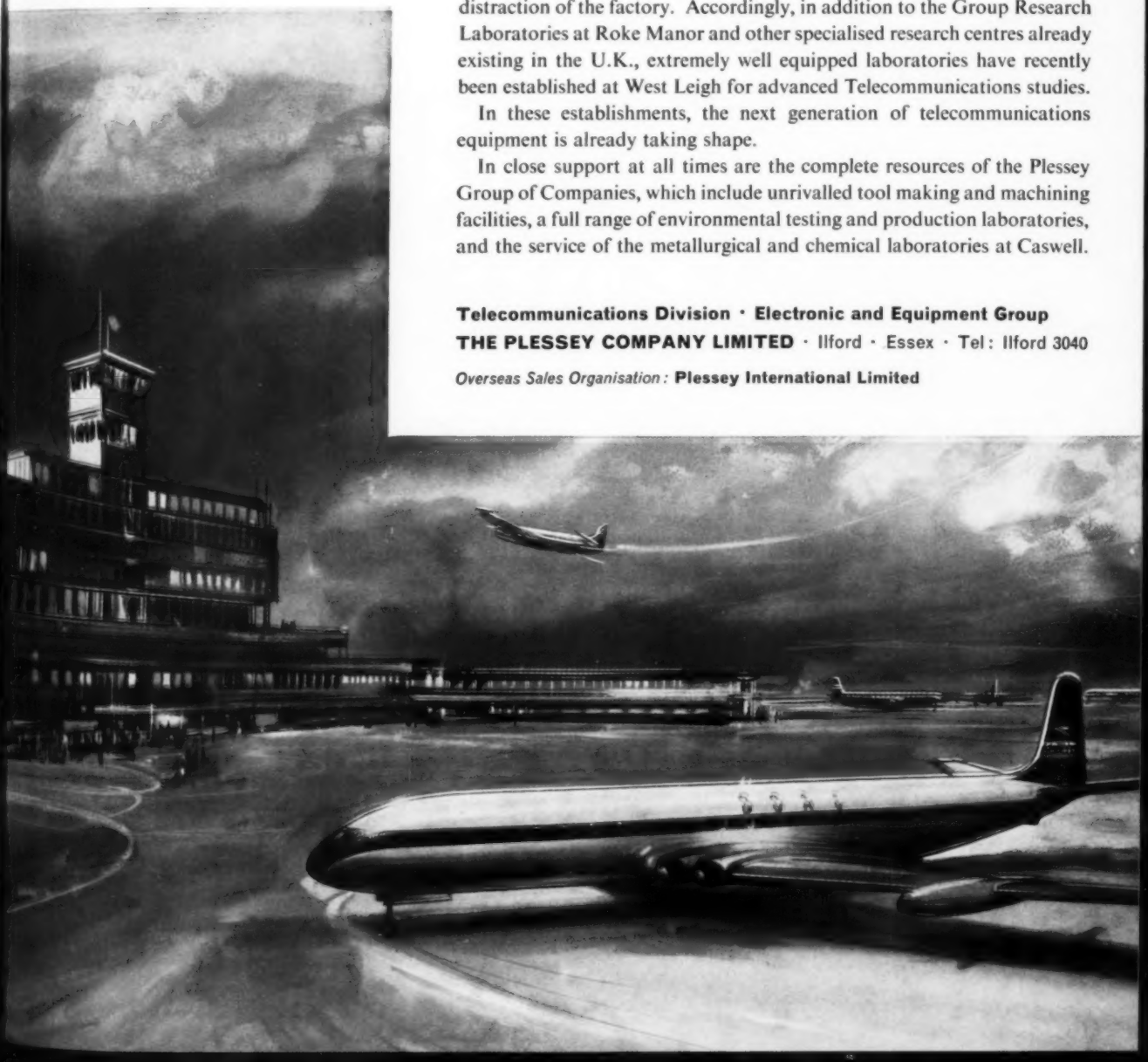

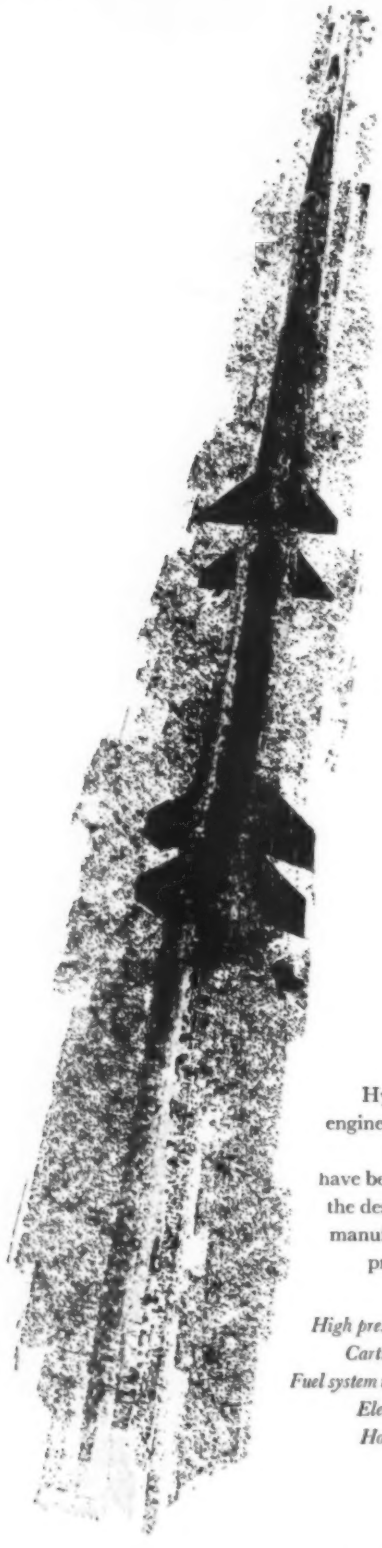

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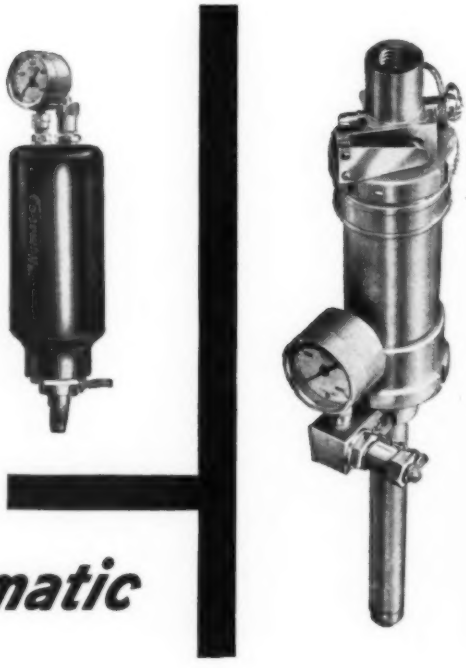

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SERVICE AVIATION

Air Force, Naval and Army Flying News

At Santa Monica, Cal, for Skybolt "compatibility check": the Avro Vulcan B.2 of No 83 Sqn ("Flight," February 3). The aircraft is expected to carry two of the Douglas missiles

South to Manby

A MOVE from North Coates southwards to another RAF station in Lincolnshire has been announced for Gp Capt D. G. Smallwood, DSO, MBE, DFC, ADC: he relinquishes command of North Coates to become AOC and Commandant of the RAF Flying College at Manby, near Louth, from next Tuesday with the acting rank of air commodore. During the war, he won the DFC for leading No 87 Sqn in attacks against gun emplacements at Dieppe, and was subsequently awarded the DSO when with No 10 Group. His post-war appointments have included the command of No 33 Sqn (1948) and of RAF Biggin Hill (1953).

Assisting UN

DETAILS of RAF transport of Ghana troops, as part of the UN forces in the Congo, have been given by Air Ministry. Initially an airlift was requested for the transport of about 1,500 troops and police, with vehicles and supplies, from Accra to Leopoldville. The first stage of the airlift, completed at the end of July last year, was carried out by Comets, Britannias and Beverleys which flew out from the United Kingdom and carried Belgian and some British refugees on their return journey. They flew a total of 37 sorties, carrying 1,356 passengers and 60 tons of freight plus 45 vehicles from the Ghanaian capital to Leopoldville. Aircraft of MEAF and of British Forces Arabian Peninsula were also engaged in flying food and supplies to the Congo and evacuating refugees. The original airlift, which it was hoped would be temporary, is now expected to remain in operation so long as Ghanaian troops act in support of the United Nations.

On August 1 last year an RAF detachment under the overall command of the AOC-in-C Transport Command was set up at Accra. Two Hastings from No 114 Sqn at Colerne were allocated for this duty [*Flight*, November 4, 1960], with supporting groundcrew at Accra and Leopoldville. Despite difficult flying conditions, encountering severe turbulence and with low cloud bases in the evening and early morning, the squadron has maintained schedules with cancellations on only one or two occasions. Political difficulties, including the closing of the airport at Leopoldville, have also been encountered. After evacuation of Ghanaian police and embassy staff from Leopoldville had been carried out, the GOC Ghana Forces (Gen Alexander sent a personal message to the RAF expressing his thanks for their prompt action, adding: "your aircrews and supporting groundcrew behaved splendidly."

Farewell to Calshot

CALSHOT is closing down and its demise is being officially marked next Tuesday by a ceremony and luncheon for Service and civic representatives. It was opened as a seaplane base in March 1913, and has been associated during its history with RAF flying-boat squadrons and with the High Speed Flight. It began life as a Naval air station, then with the amalgamation of the RFC and RNAS in 1918 into the Royal Air Force, the three flights of aircraft at Calshot were combined to form No 240 Sqn. In the inter-war years it was the centre for practically all RAF maritime air training.

Its use as headquarters for the High Speed Flight began in 1927 when the team which won the Schneider Trophy in Venice trained there. In September 1929, it was the venue for Britain's defence of the trophy, and in 1931 the race which won the trophy outright for Britain was flown there.

Since the war, Calshot has been a base for Sunderland squadrons, these aircraft operating from there in 1948 on the Berlin airlift. The station was transferred to Maintenance Command in 1953, and since then No 238 MU has been responsible for all major RAF marine craft repair and maintenance.

The Queen chatting with F/Sgt P. Marshall, secretary to the Air Adviser, UK High Commission in Pakistan, after investing him with the BEM at the President's Palace, Karachi

Sir John Hunt with members of No 281 (Southport) Sqn, Air Training Corps, after presenting badges and certificates at RAF Woodvale under the Duke of Edinburgh Award Scheme, of which he is secretary. At right is the OC West Lancs Wing, WG Cdr L. Harrison; at left, the 281 Sqn CO, Flt Lt W. Lund

Facsimile Weather

EQUIPMENT worth £A45,265 is being installed at the RAAF transmitting station near Canberra for the broadcasting of facsimile meteorological charts and teletype messages, capable of being received throughout Australia and as far south as the South Pole, northwards to Malaya and the Philippines, west beyond Cocos Island and eastwards to Hawaii and the Pitcairn Islands. The equipment will comply with WMO standards, and its operation will make Australia one of the first countries in the world to introduce facsimile broadcasts of weather maps.

Aiding Accident Prevention

AN RAF medical officer who qualified in medicine after serving as a wartime bomber pilot, Sqn Ldr T. G. Dobie, has been awarded the Richard Fox Linton Memorial Prize for his work in connection with aircrew emergency procedures and the investigation of flying accidents involving injury. During last year, while Deputy Principal Medical Officer at Flying Training Command headquarters, Sqn Ldr Dobie visited the locations of all flying accidents in which casualties occurred. Subsequent proposals for emergency drills, largely formulated by him, have been accepted as the basis for reviewing current procedures. The Flying Training Command major accident rate in 1959 was the lowest ever recorded.

IN BRIEF

Live TV pictures of the total eclipse of the sun were to be transmitted from a Varsity of RAF Signals Command flying at 10,000ft above Selsey Bill, Sussex, last Wednesday.

The 150 men at RAF Sharjah on the Persian Gulf raised £600—believed to be the largest *per capita* contribution by any RAF unit—during Battle of Britain Week last year.

No 84 Sqn reunion is being held at the Artillery Arms, Rochester Row, London SW1, on Saturday, March 11, at 7 p.m. Further particulars from Owen Greenwood, Flat 24, 62 Belgrave Road, SW1.

The RAF Reserves Club ball is being held at the Dorchester Hotel, Park Lane, London W1, on Thursday, March 2. Tickets (2½ guineas each) and table reservations are available from the Secretary, RAF Reserves Club, 14 South Street, London W1.

President de Gaulle is to inaugurate the new airport buildings at Paris Orly at the end of this month. Here is a general picture of the main terminal building nearing completion

AIR COMMERCE

SILVER CITY: THE DEFINITIVE MOVE?

MANY observers believe that changes in Silver City's structure are inevitable if, despite future annual rises in passenger and vehicle traffic, the airline is to operate the short Channel crossings on a profitable footing. When turn-around time is an inevitably high proportion of time-in-the-air, rising engineering costs cannot easily be offset by increasing utilization. This is among the reasons for Silver City's applications to operate deeper-penetration routes to Paris, Auxerre and Cologne (about which they have seemed a little half-hearted) and for services from provincial centres in Great Britain to the French coast—in which they appear to believe more strongly.

But long-range routes alone will not solve the problem to which their main competitors, Channel Air Bridge, have already found a solution—new aircraft to absorb the volume of traffic built up with Bristol Freighters and opening up long-range routes with more modern and more economical aircraft. Since their deal fell through with the British Transport Commission last March, Silver City have been manœuvring behind the scenes to obtain re-equipment capital from other sources. Often their eyes have turned towards France, with the result that it has been variously suggested that Mr Eoin Mekie would equip his Air Ferry with Hurel-Dubois HD 32s, Handley Page HPR.8s (to be built partly in Great Britain and partly by a consortium of French companies) or with Breguet Deux Ponts.

There were strong possibilities earlier this week that Silver City would link up with handling and sales agents Compagnie Air Transport, shares in which are owned by French National Railways, French airlines and French shipping. CAT handle Silver City in Paris. They are not transport operators, but under the proposed agreement, it was reported in the *Sunday Telegraph*, Silver City would sell three Bristol 170s to CAT, and operate them on behalf of the French company on the routes to Calais and Le Touquet from Lydd. Costs and revenues would be pooled.

Nothing had been signed as this issue went to press, although the board of British Aviation Services were meeting to discuss the French proposals. It seems unlikely that more than a minority interest in Silver City (who are controlled by P and O) would be taken by CAT. On the other hand, Silver City are likely to insist that any agreement paves the way for the purchase of new aircraft.

If it does, the situation will contrast strangely with that ten months ago, when Silver City announced the HPR.8. On this occasion (*Flight*, April 29, 1960, page 607) Mr Mekie was asked about the new aircraft:—

How would it be financed now that British Railways were not to invest in the airline? "I know where the money is coming from," said Mr Mekie, "but I am not prepared to say. It will not be French money." Were French Railways involved in any way? "No."

Over last weekend, Silver City announced a new air ferry service between Guernsey and Manpertus Airport, Cherbourg, at a weekly frequency until September 9, and increased frequency thereafter. Passenger fares are £3 single and vehicle fares on the usual graduated scale. At the same time, the cargo service from Hurn to Guernsey is being increased from one to five services weekly and rates have been reduced down to 5d per kilo.

TEAL LOOKS TO BOAC

BOAC may be the instrument with which Tasman Empire Airways achieves New Zealand's long-haul aspirations. New Zealand contends that its flag carrier should operate under its own control on international routes, but this has been impossible while the airline remains under the present Australian-New Zealand joint ownership.

New Zealand has now decided to buy out Australia's 50 per cent interest in Teal; the price Australia will ask is around £A1m. New Zealand will also have to agree to Qantas running a Tasman service, probably a parallel service, on all routes now operated by TEAL between New Zealand and Australia. At present there are services between Auckland, Wellington and Christchurch to Melbourne, Sydney, and Brisbane.

On the assumption that New Zealand could find the money to buy its neighbour out, during 1960 traffic rights for TEAL were discussed both with France and the USA. In exchange for agreement for TAI and PanAm to operate over TEAL's previously exclusive Tasman Sea route between Auckland and Sydney, New Zealand would gain rights to extend its Coral service route via Tahiti and Hawaii to California and possibly beyond. But unless capital or assistance could be found for re-equipment, TEAL would be in the position of operating its Electras against PanAm and TAI jets. It is reported that TEAL may take two of Qantas' Electras as part of the change-of-ownership deal; one is already on charter for the Tahiti service.

BOAC's proposal, as suggested by Sir Matthew Slattery, is a partnership between the corporation and TEAL including the offer—on a lease basis—of long-range jets. BOAC would extend its London - Los Angeles jet service (due to be inaugurated on March 2) to New Zealand, with TEAL operating the Pacific sector. Australia would be "fully consulted" and aircraft would be supplied to New Zealand under a pool set up by BOAC. The corporation would not renew the 20 per cent shareholding withdrawn in 1954 because, said Sir Matthew, it is not necessary; the partnership he was proposing would be one of sharing of costly equipment.

In a guarded comment on these proposals, Mr J. K. McAlpine, New Zealand's Minister of Civil Aviation, said before meeting his Australian counterpart Senator Paltridge this month that four possibilities were open to New Zealand in respect of TEAL: selling its share, which he did not favour; buying Australia out if Australia consented, which might involve heavy losses (though it is reported that Australia might accept a long-term repayment); continuing the present partnership; or persuading some other airline to act with TEAL under New Zealand ownership.

It is not generally known that among the export customers for the Ilyushin Il-18 is Air Guinee, which becomes the second African carrier to fly its flag on this airliner —the other being Ghana Airways. The quantity of Il-18s operating in Air Guinee colours is not known; probably, like those of Ghana Airways, they are operated by Soviet crews

Wearing the special medals pinned on them last week by Emperor Haile Selassie is the crew of the Ethiopian Airlines DC-6B which flew the Emperor on his recent State Visit to West Africa and Brazil

BOAC's HUNGRY FREIGHT HOLDS—

FIGURES just published by the Ministry of Aviation for British air traffic in November 1960 show continuing healthy rates of increase. BOAC's efforts to increase western-routes business continued, and total capacity ton-mileage made available on these routes in the twelve months ending November 1960 increased by no less than 42.6 per cent. However, load factor fell to the uncomfortably low figure of 50.7. In the month of November itself, though ton-mile capacity was increased by a staggering 60 per cent, traffic increased at less than half this rate. The western BOAC picture seen in the light of passenger business does not appear so disquieting. Seat-mileage offered by BOAC on western routes went up by nearly 36 per cent to more than two million in the twelve months ending last November, passenger-miles increasing by nearly 31 per cent to 1.2 million. Passenger load factor fell by just over two points to 58.9 per cent.

These results provide a measure of the emptiness of BOAC's 707 and DC-7F cargo holds, and have to be considered in the context of the corporation's efforts to cut cargo rates at the recent Paris conference (see col 2).

BOAC's total overall load factor on *all* routes in the twelve months ending November 1960 was a reasonably satisfactory 57.3 per cent, only half a percentage point less than in the corresponding previous twelve months. This is because of a healthy uplift on eastern and southern routes, where overall load factor was nearly 65 per cent—the result of traffic increasing by nearly 17 per cent while capacity increased by less than nine per cent. Passenger-mileage on these routes during the year under review went up by 25.6 per cent, a nicely judged response to exactly the same increase in the seat capacity that was scheduled.

—BUT IATA FAILS TO AGREE

WHEN IATA's Cannes conference ended last October with a two-year agreement on passenger fares, it was decided to hold a special conference on January 23 to discuss "new approaches to cargo rating to encourage greater bulk traffic"—primarily over the North Atlantic. The meeting duly took place in Paris, and it ended on February 10 with no agreement. This means that unless agreement is reached by April 9, when the present North Atlantic cargo fare agreements expire, an open-rate situation may exist. Already BOAC have spoken of "consulting the Government" about cutting cargo rates. Rather more outspokenly, Pan American and TWA have both said that they intend to "go it alone" on April 10, and Seaboard & Western have declared that they will introduce *their* proposed fare structure on July 1. Thus a cargo war on the Atlantic now appears quite likely.

The basic conflict is over the American proposal to do away with all the special commodity rates. These promotional cargo tariffs yield about two-thirds of North Atlantic freight traffic, but Pan American, TWA and Seaboard & Western want to scrap the system and introduce in its place a reduced overall rate with higher "break points" to stimulate bulk cargo. At present there are two break points: consignments weighing up to 45kg cost about 20s to send from London to New York; thereafter the price comes down to about 15s per kg. At 500kg, the price comes down again by a shilling or two depending on circumstances. Pan American want to cut the 20s to 13s, the 15s to 8s, and want to introduce a new break point, at 7,500kg, where the rate would come down to 5s. It is believed that the TWA proposals are similar.

Seaboard & Western, the only all-freight specialist on the Atlantic, is planning to introduce the first of its five CL-44D4s on July 1, and it has the problem of filling aeroplanes with a 65,000lb payload (30,000kg). The DC-7Fs and Super Constellation all-freighters used by the other carriers have payloads of only about half that of the CL-44D4. Seaboard & Western's proposed cuts are not, however, as great as those of Pan American, except that it wants to charge about 4s a kilo for full CL-44 consignments of 30,000kg—and wants also to increase commission to freight forwarders and cargo agents as an incentive.

BOAC say that their proposals, which are believed to specify cuts in commodity rates rather than drastic reductions in the general rate, would produce "a lower overall rate than any other recommended." Mr Gilbert Lee, BOAC's commercial director, said last week: "We now have vastly increased cargo capacity on our high-frequency, high-speed Boeing 707 jet flights and on our regular transatlantic freighter services, and BOAC is determined to keep in the forefront of the move to reduce freight rates for shippers and agents and to do all it can to help the new British export drive."

The cargo rate pattern in Europe, the Middle East and Africa stands without change, so that BEA's desire to extend to all routes the commodity rates at present applicable to only certain routes does not appear to have been acceptable. However, a special IATA group has been set up to meet in May to consider a study of the European rating structure which a group of European carriers has now embarked upon.

THE AMERICANS GET TOUGH

EVERY foreign airliner is now regarded by the Americans, it was recently said, as a bird of prey. As the Italians, Dutch and Scandinavians have discovered in the past year, it is certainly becoming more and more difficult to obtain traffic rights from the United States. In fact, it would not be an exaggeration to say that a major reversal of American policy concerning the freedom of the air has taken place.

The Civil Aeronautics Board has just drafted a new regulation which, if it is enforced, may require foreign countries to curtail their air services to the United States. The proposed regulation would give the CAB powers to do two things:—

(1) Call upon all holders of US foreign carrier permits to submit to the CAB details of all present and future schedules and—this is the controversial requirement—to produce traffic data;

(2) Require a hearing into a request by any foreign carrier to include a new stop in its route to US territory, even though such a stop may be included in the bilateral agreement or US foreign carrier permit. The first of such hearings is scheduled to start on February 23.

It may be assumed that the reaction of the British Government to this latest American move will be vigorous and immediate. It certainly seems incredible that such a controversial step should have been taken at a time when air traffic relations between the two countries, following the breakdown of talks in Washington last May, are in such a delicate state. It is believed that the Government has told the Americans to forget about the idea of having hearings on February 23, and has presumably reserved the UK's rights to disagree that hearings are necessary anyway. It may also be assumed that the majority, and probably all, European governments are co-ordinating their opposition to the American move.

If this means, as seems evident, that the Americans are proposing to put capacity limitations on foreign airlines serving US territory, the implications could be interesting. It has always been the Americans who have rejected the restrictive approach to air commerce. The five freedoms of the air agreed at Chicago in 1944 were a compromise between the liberal freedom-of-the-skies outlook of the Americans and the more restrictive approach of the less well-endowed (from the air transport point of view) countries, including the United Kingdom. The Bermuda agreement of 1946 between the US and the UK did not call for the placing of restrictions on capacity offered; instead it provided for a reasonable relationship between supply and demand, and for *ex post facto* review whenever one country felt that it was being "swamped" by the other.

The Bermuda principles, which have served air transport well, now appear to be in jeopardy. The Americans are concerned at the increasingly heavy demands made on them by foreign airlines. The coming of the long-range jets has radically altered many of the piston-era route schedules agreed between countries, and—as the recent conflict between the Americans and Scandinavians illustrated—there is discord over the meaning of fifth freedom and

AIR COMMERCE . . .

***Elle a volé parfaitement:** the first of 20 Caravelle 6Rs for United Air Lines (Rolls-Royce Avon 532Rs of 12,375lb static thrust) made its first flight at Toulouse on February 6 in the hands of Sud Aviation's director of flight test Pierre Nadot. United will put Caravelles into service this summer*

the whole question of the so-called "beyond" rights enjoyed by foreign airlines picking up Americans in America. They evidently feel that it is now necessary to give meaning to the deliberately vague provisions of the Bermuda-type agreement, and that statistics relating to the origin and destination of traffic should be produced. This was something which the Americans managed to get the Italians to agree to last summer.

If the Americans do adopt the more restrictive approach that they have deplored in other countries, and call for the predetermination of capacity, hopes for the greater freedom of air transport will have suffered a sharp reverse.

SCANDINAVIANS IN THE RED

THOSE who regard SAS as a model of airline efficiency and international co-operation will be saddened to note the very heavy loss suffered in the year ended September 30, 1960. In round figures the airline's deficit was £5.8m. Heavy injections of new capital are now required, and the governments of the three Scandinavian countries are considering the recent SAS proposal for a doubling of share capital to more than £20m.

The reasons for SAS's financial difficulties are not easy to discover, but it would appear that the airline is not the model of efficiency that is generally supposed. Any one index of efficiency can, in itself, be misleading; but among the world's dozen biggest airlines (see graphs below), SAS has the lowest staff productivity—less than 20,000 capacity tonne-kilometres per employee (BOAC are now approaching 40,000). Measuring staff productivity in terms of total flying hours per employee, SAS are also well down the list, this index having been declining steadily from a level of about 17hr in 1956 whilst that of the other major European long-haul operators—Air France, KLM and BOAC—has been rising.

BOAC's EFFICIENCY

ONE of the most remarkable and welcome trends in British air transport today is the way in which BOAC is reducing its cost level. Though the corporation itself has not made much of a song and dance about this—surprisingly perhaps in view of the extent of the achievement—a recent *Flight* analysis of BOAC's cost level compared with that of other airlines has produced figures which show how the corporation's efficiency is improving.

The graphs below show how BOAC's cost level has been steadily reduced over the past three years from the peak level of about 40d per c.t.m. in 1956-57 (to convert from cents per tonne-kilometre to pence per capacity ton-mile multiply by 1.25) to 32d in 1960.

Undoubtedly the biggest single contributory factor has been BOAC's success in reducing its engineering cost level. The adverse publicity suffered by BOAC on this count ("BOAC has 3,000 too many engineers," etc) is part of the very recent history of the corporation. The Select Committee on Nationalized Industries noted in May 1959 that, on the corporation's own admission, "the engineering organization and methods require fundamental revision," saying "it is the responsibility of the management of BOAC to achieve at a very early date a drastic improvement in the productivity of their aircraft maintenance department," and that until this had been done, "BOAC cannot expect to compete on even terms with other airlines of the world."

In September 1959, Mr Smallpeice announced his intention of slashing engineering cost level from 10½d per c.t.m. (8.4 cents per tonne-kilometre) in 1957-58 to 9d in 1958-59, 7d in 1959-60, and 5½d (4.4 cents per tonne-kilometre) in 1960-61. In fact, as the right-hand graph shows, a figure of 6½d was achieved in the calendar year 1960. Furthermore, it was the intention to cut cost per c.t.m. from 36d at the beginning of 1959 to between 29 and 32d per c.t.m. at the beginning of 1961. In fact, the 32d level was reached in calendar-1960.

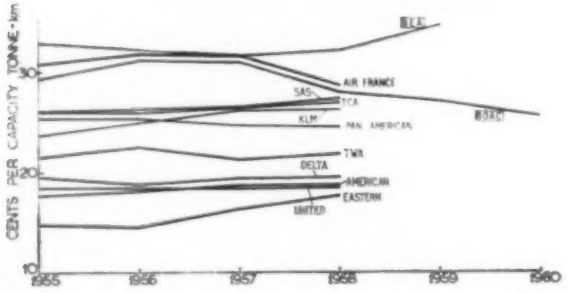
Less cheering is the upward trend in BEA's cost level, even before the introduction of new equipment. BEA's high relative costs are largely accounted for by the special nature of their sharply seasonal short-haul network and though no figures are available for 1960, it is believed that BEA managed to hold costs down in that year. An upward trend in BEA's engineering cost level is apparent, however, and it is probable that (comparing like with unlike) it is now BEA, and not BOAC, that has the higher engineering cost level.

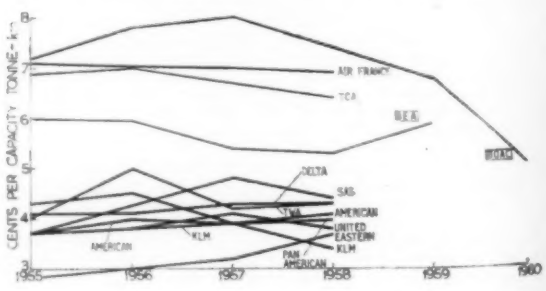
What is a little disturbing about BEA's unit costs is the fact that an upward trend began before the introduction of new aircraft. Though the UK cost of living index went up 11 per cent from 148 in 1955 to 164 in 1959, and BEA had to bear the cost of writing down the new engineering base extension, it remains to be seen what effect on BEA's cost level will be made by the Comet, which—though a fine revenue-earner—has a cost per c.t.m. on BEA's routes some 20 per cent above that of the Viscount.

At any rate, it looks as though BOAC is ridding itself of its old inefficiency label, and that the Smallpeice-d'Erlanger partnership laid sound foundations for the Smallpeice-Slattery partnership.

J.M.R.

These "Flight" graphs reveal the remarkable success achieved by BOAC since 1956 in its efforts to improve efficiency. Trend in total cost level is seen on the left, and in engineering cost level on the right. The ICAO measure of US cents per tonne-km is used to provide a comparison with the world's ten other top revenue-earning carriers. Not so encouraging is the upward trend in BEA's cost level





LESSONS OF A TURBOPROP INQUEST

BELOW are abstracts from the FAA report on the most intensive accident investigation in US aviation history, after major accidents to Lockheed Electras at Buffalo, Texas, in September 1959, and at Cannelton, Indiana, in March 1960. The second crash was the outcome of a structural failure almost identical to that suffered by the first aircraft.

FOLLOWING a meeting with the president of each airline operating Electras, Lockheed and Allison, the Federal Aviation Agency initiated a five-point programme:—

(1) *Emergency airworthiness regulations.* Reduction of the originally certificated normal operating speed of 373 miles per hour to 259 miles per hour. This speed restriction provided an additional airload margin of 50 per cent between the maximum loads expected in normal operation and the structural capability of the airplane, and a more rapid slow-down to rough-air penetration speeds. The autopilot was deactivated until it could be proven that it was blameless. Pressure-refueling procedures were stressed to prevent straining by overpressurization of the tanks.

(2) *Emergency maintenance inspection.* The FAA inspected all Electra wings and daily checks were made of engine reduction gears. After severe turbulence or hard landings a thorough structural inspection was given before flight was again permitted.

(3) *Special air carrier operations inspections.* Emphasis was placed on instruction of flight crews in the new speed limitations.

(4) *Flight recorders.* The FAA required that flight recorders—giving a permanent record of airspeed, altitude, direction, and acceleration—were installed in all Electras.

(5) *Engineering and research investigations.* Lockheed was directed by the FAA to undertake a program re-evaluating the Electra design. This included a flight-test program to demonstrate the soundness of the airplane with respect to manoeuver and gust loads. Particular emphasis was given to the ability of the wing to dampen after it was disturbed and loaded by air gusts. The control system was examined to determine the effect of malfunctions, and basic engineering data on strength and stress analysis was reviewed.

An accelerated flight test program of a highly instrumented Electra was started, to obtain data to demonstrate aerodynamic and structural characteristics of wings, nacelles, and control surface assemblies. Manoeuvers, gust penetration, and flutter response tests were conducted over a range of weights, speeds, and fuel loads sufficient to ensure that any hitherto unsuspected abnormal structural effects present would be revealed.

The following conclusions were drawn: (1) The original design manoeuver loads were correct. (2) During an abrupt pull-up stability characteristics are normal. (3) No abnormalities are present in manoeuvers such as rolling pull-ups.

The Electra was flown through heavy turbulence to measure what affect gusts had on the wing and fuselage structure. This gust flight program was most extensive and far-reaching. New knowledge was gained about analyzing airplane stresses.

Lockheed was directed to evaluate the control system and autopilot in respect of possible malfunctions, failures, and induced effects to insure that sudden destructive forces were improbable. As a result, FAA approved a series of changes to the control system and autopilot.

Proving the Structure

The most important part of the analysis was that related to proof of the structure itself. The extensive flight test program made it possible to validate estimated aerodynamic loads with actual loads. This process permitted a reaudit of the structure, including: (1) Integration of flight program data. (2) Review of existing statistical data on magnitude, frequency, and characteristics of Electra gusts. (3) Re-investigation of flutter and divergency analysis, including consideration of abnormal situations arising as a result of failures such as damaged gear box support structures, complete loss of one engine, and damaged wing structures. (4) Wind tunnel investigations to obtain aerodynamic data both for normal configurations (including propeller-induced effects on airflows, forces, and other phenomena, and including varied propeller inflow angles) and for abnormal conditions arising as a result of structural damage or failure. As a result of these studies and tests it was concluded that under certain conditions of engine nacelle or powerplant damage, a phenomenon, known as "whirl mode," could occur.

As a wing is loaded intermittently (as might occur when encountering gusts) it must return automatically to its previous position. Good damping requires that a motion of this sort die out rapidly. The damping forces are those which take energy away from the oscillations. A small amount of damping comes from internal energy absorption in the structure and energy absorbing parts such as rubber engine mounts, but the greatest damping comes from designing the structure so that the aerodynamic forces on the airplane resist the motions and thus absorb energy from the oscillations. Conversely, if the air forces aid the motion, the oscillation grows—this condition is known as flutter.

The Electra wing has good positive damping, but the studies conducted during the re-investigation show that while the control system could not induce wing oscillation, the wobbling of an outboard propeller could. If there are certain structural failures in the outboard powerplant installation, the stage could be set for a wobbling propeller condition.

Since a propeller has gyroscopic characteristics, it will tend to stay in its plane of rotation even though it may be loosely mounted. It will hold its plane of rotation until displaced by some strong external force such as atmospheric turbulence, abrupt aircraft manoeuvers and sudden power surges. When such a force is applied, the propeller reacts 90° out of phase with the applied force. Assuming the propeller is displaced upwards, the structural resistance of the mounting system applies a nose-down pitching moment. The propeller disc, when viewed from the rear, will then precess to the left. The yaw stiffness causes a nose-down pitching, which is in turn resisted structurally, resulting in the propeller disc yawing to the right. The yaw stiffness on that side then causes a nose-up pitch to complete the cycle. This effect has been termed the whirl mode, and its direction of rotation is opposite to that of the propeller.

Violent Whirl Mode

In a healthy airplane, the whirl mode can operate only within the limit of flexibility of the engine mount, and is damped out very quickly. However, if some structural element of the powerplant, mounting or nacelle is damaged—so that stiffness of the propeller supporting system is reduced below normal—then the whirl mode would not damp out rapidly at high airplane speed. Powerplant installation damage in the Electra did not significantly change the conditions under which the whirl mode might have been initiated, but it made that phenomenon, which is not hazardous in itself, become threatening in three ways. First, the greater flexibility of a weakened installation allowed the whirl mode more freedom and it could become more violent. Stiffness normally increases rapidly as deflections approach the mount limits, but in a damaged installation this characteristic might be altered. Second, in an installation where the strength level is reduced, this, in combination with the increased force and violence of the whirl mode, could lead to further progressive damage and thus to further reductions in stiffness. Third, and most important, this changing spring constant is a condition wherein the frequency of the whirl mode in an over-flexible structure could have reduced from its natural value (which is safely above the fundamental natural vibration frequencies of the wing), to lower values which approached the wing's natural frequencies. As the whirl mode progresses, the frequency of the mode could approach the natural frequency of the wing, which would in turn tend to perpetuate the whirl mode. Oscillations would then be coupled at the same frequency. This is a form of induced flutter, forced by a powerful harmonic oscillation to occur at a lower airspeed than that at which classic flutter can develop. This could produce a catastrophic failure through severe oscillatory divergence.

Identification of the whirl mode phenomenon was the key to the mystery which had baffled the aviation industry for months. The correction of the various wing, powerplant and nacelle deficiencies was, in retrospect, relatively simple once the problem was identified. The modifications were (1) to add additional mounts to stabilize the propeller should any member fail, or should breakage occur between the gearbox and the power section; (2) to strengthen the nacelle structure by reinforcements and diagonal braces; (3) strengthening the wing by increasing the thickness of three lower surface "planks" and one upper surface plank, reinforcing the front spar and the wing lower surface and strengthening eighteen ribs in each wing by additional diagonal braces and reinforcements.

Dramatic flight tests were completed during the latter part of December on a modified Electra. The FAA required a test of failure of the torque shaft and the torque shaft housing. These were, in fact, removed prior to flight. The airplane was dived at speeds up to 418 miles per hour in this weakened condition. Severe flight loads were imposed by the pilot to record strains on the critical parts of the structure. Instruments revealed complete absence of the whirl phenomenon or any other adverse condition.

Under FAA control, Lockheed is modifying aircraft at a rate which will permit all to be completed by the middle of 1961. As each airplane is completed, its speed restrictions are automatically removed and it is expected that airlines will return to the high speed schedules as soon as they have a substantial part of their fleet modified.

AIR COMMERCE . . .

BEA v THE LANDLORD

NOT since BEA was formed has the corporation spoken out against the Government in public so strongly as it did last week. Complaining about London Heathrow's runways—which, because of repairs, require some flights to be diverted to Gatwick—a spokesman said: "The runway position at London Airport is impossible. Here is an airport on which £30m has been spent and yet we must divert services to other airports because London cannot take them." There was, he said, an increasing feeling that London Airport should be managed and run by an independent authority "instead of civil servants who have to refer everything to headquarters, with the consequent loss of time and no definite decisions being made."

A few days later, protesting that aircraft diverted to Gatwick had to pay a further landing fee when repositioning at Heathrow, a BEA official said: "Diversions mean that aircraft have to be flown back to London Airport with no payload. To add a further landing charge seems incredible, and only a Government organization could get away with it." As for the proposed new landing charges, he added, these were "iniquitous."

Meanwhile, BEA have served a writ on Manchester Corporation following a difference of opinion about the airline's right to load its own aircraft at Manchester Airport. BEA want a court ruling on their rights by April, in time for the summer season.

The case is likely to have wide repercussions. At Ministry-owned airports in the UK the legal position appears to be that no one is entitled to perform apron services without the permission of the Ministry. However, the Ministry has never compelled operators to use its apron services, even though the Treasury in 1952 recommended that it should.

No doubt it is because of BEA's general dissatisfaction with its airport landlord, the Minister, that the corporation is now proposing to build its own terminal at London Airport Central. The building will cost nearly £1m and will take one or two years to complete. The Ministry have set up a working party with BEA so that the Minister can "give the request further consideration when he has a full report." The most interesting point here is that the Minister has not—as he could very easily have done—turned down the proposal out of hand.

BREVITIES

It is reported that Aloha Airlines of Honolulu are considering an order for six Argosies to operate freight and passenger services in Hawaii.

It is learned that Cathay Pacific has decided to purchase Boeing 720s to replace Electras on the Hong Kong - Sydney route in 1963.

The Lord Privy Seal stated in the Commons last week that the Government has presented Mali with three DC-3s at a cost of £80,000.

UAA has bought three DC-6Bs from SAS for about £205,000 each.

Kuwait Airways may, by arrangement with BOAC, operate international routes with Comets.

The first Indian-manufactured Avro 748, which is being constructed by Indian Air Force Maintenance Command at Kanpur, is expected to be ready for flight before June 1.

Trans Arabia Airways, which last year cancelled a firm order for two Argosies, is said to have $5m available for a possible order for two Boeing 720s. The airline recently bought a DC-6A through Field Aircraft Services.

Ghana has confirmed its order for two Boeing 707-420s (*Flight*, February 3, page 162), for delivery in July and August 1962. Meanwhile El Al have ordered a third 707-420. Total number of 707/720s on order is 261.

Subject to government approval PIA is to inaugurate a service to New York on May 7. There will be one return flight a week out of London on Fridays. Services to Tokyo may be started in 1963.

KLM has signed an agreement with VIASA of Venezuela for technical, operational and commercial co-operation. VIASA is to lease a KLM DC-8 with crew for services between Caracas and Rome, Paris, London and Amsterdam next April.

THE NEW SHAPE OF THE INDUSTRY (continued from page 200)

cushion on which to sit down and grow fat? That is the same old problem, isn't it?

"We are up against that hardy annual. For myself, I think it can be done. We now have a good industrial set-up, and I think I have the chaps, resources and equipment deployed in the right way. But we have to cope with the sort of competition which Boeing can put up, largely due to their massive Government support, and we need proper assistance. No one is infallible in this business, either with airframes or with engines, and, as I said, a 5 per cent increase in costs can mean a very serious problem indeed."

* * *

It was at this point that we were interrupted by a telephone call from Ghana with the news that the contract for three VC10s had been signed. It was a most agreeable experience to have this early news of a £7m confirmation of Sir George's confidence in that aircraft. He was especially pleased with the fact that the first order from an overseas operator should come from the commercially uncommitted African Continent. I agreed with him that in these emergent countries we are only beginning to feel the possibility of their latent purchasing power. I ventured to express the opinion—and the hope—that it might well be from Africa or Asia that another call might come with news of additional orders for the Vanguard.

His frank reply was that the call could not be delayed very much longer or the chances were that the massively expensive jigs and tools on the production line would have to make way for VC10 expansion. Thinking of the capital sum in this aircraft with its ultra-low-cost transport possibilities, one had another sharp illustration of the risks involved in making modern civil aircraft.

* * *

From consideration of the Vanguard we turned to another topic that has been much in the news.

What is the outlook for the supersonic airliner?

"It's all fairly straightforward. We have the central set-up inside BAC with Dr A. E. Russell as the Chief of Staff, but the project is split up all around the group, and we really have harnessed the group's entire ability. I am talking about a Mach 2 aircraft, for that is all that any airline will be able to absorb within the next ten years."

You were emphasizing, even for the subsonic projects, that the risk is intolerably big; when we get to the supersonic, isn't it too big for any national group? Haven't we, then, an international requirement?

"Yes. We cannot afford a head-on collision with the Americans if we can avoid it, and I am prepared to collaborate with them."

But with such collaboration are we not up against the same question of who is going to be the boss?

"I suppose that the fellow who puts up the most money will be made the boss. My view is that collaboration with the USA is quite practical, and can be entirely satisfactory so long as they do not wish to hare off on a Mach 3 machine."

But aren't the mechanics of collaboration going to be more difficult? Instead of teams in Weybridge and Warton keeping in touch, won't it be a matter of constant to-ing and fro-ing between England and Seattle?

"Let me put it this way. The obvious gains would be well worth the inconvenience. With a properly organized and sensible arrangement we should be able to feed the airlines with the supersonic airliners as and when they can take them. In this way supersonic travel could be a benefit—not simply for the industry, but for everyone who wants to get about the world on business.

"The alternative is a cut-throat competition in which the new machines would be forced into service too soon, with consequences that could be terrible to all concerned. So that, whilst it might well be difficult to design and develop an aircraft with teams split up between here and North America, I suggest that the prize at the end of it makes the effort infinitely worthwhile."

Just to sum up, you could say that the past year has been satisfactory and the outlook quite bright?

"For myself, I have had a most exciting and interesting year. I think the new set-up can work and give British aviation a second wind. But the Government must realize—and I believe they do—that stability is essential if the industry is to survive. Contracts must be placed only when enough thought has been put in that the chances of subsequent cancellation are slight. Help for our civil projects must be realistic, both in the light of the help which the big American companies receive from their Government and also when viewed against the history of rising cost. As I said before, 5 per cent of £100m is a lot of money to be left with. I've been a heavy critic of costs when they've gone wrong, but these civil contracts need fixed prices six years before delivery. The most efficient outfit is likely to find 5 per cent over that period a pretty small margin."

* * *

I could not have asked for a more honest appraisal of problems and possibilities. And what a wide range of possibilities there is, with the Vanguard just beginning to demonstrate its worth in day-to-day airline work and Sir George stating, with quiet confidence, that he is "ready to collaborate with the Americans" on a supersonic transport. We may yet see in the next twelve months as many interesting developments in the British aircraft industry as in the past eventful year.

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Sterling Metals were privileged to supply both engine and airframe castings for the de Havilland Dove 8 recently delivered to J. C. Bamford (Excavators) Ltd.

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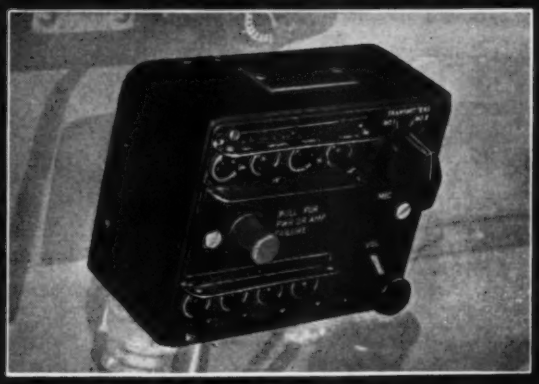

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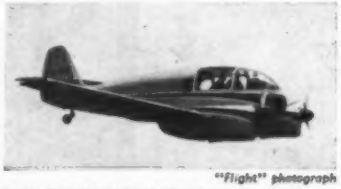

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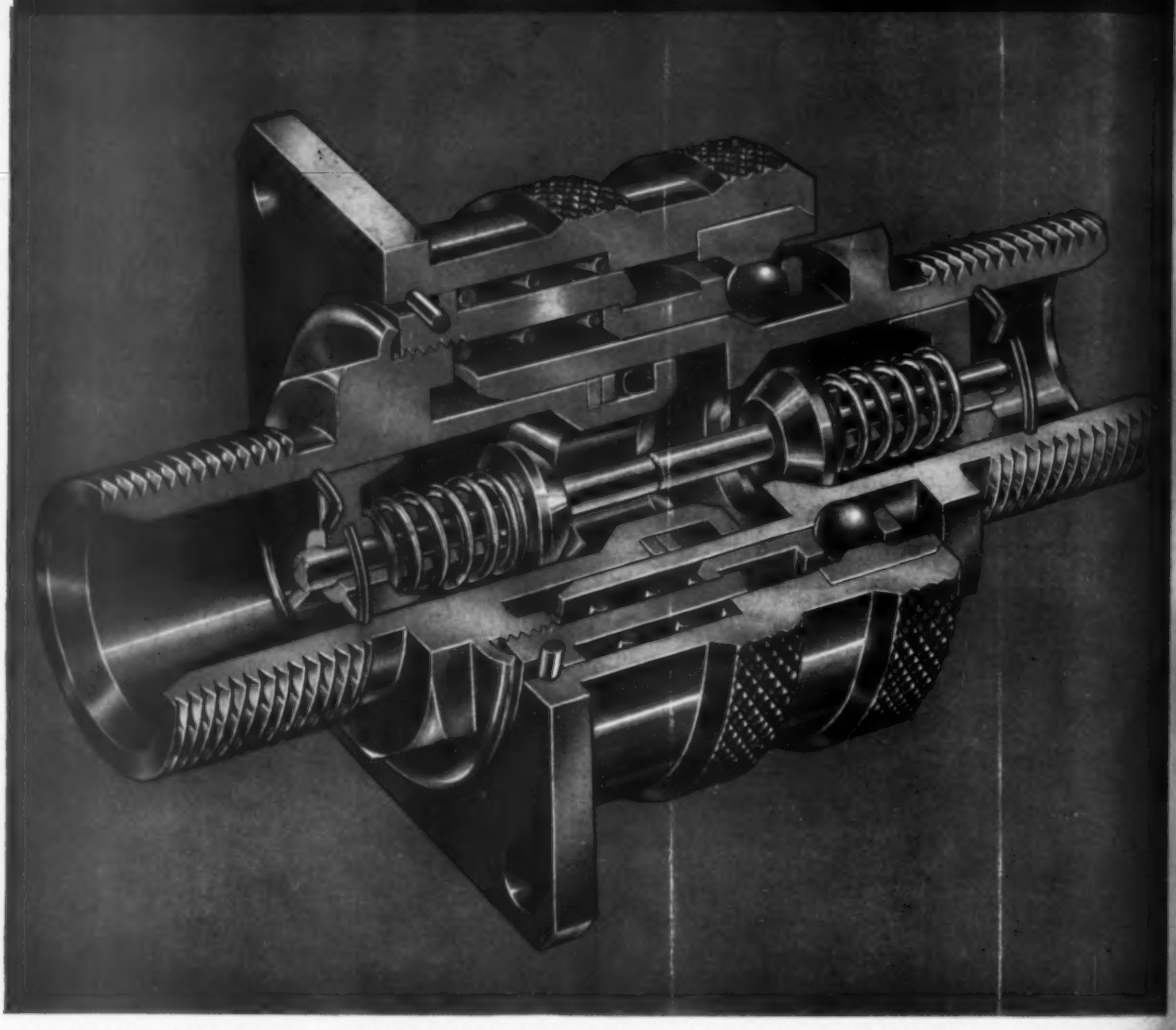

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